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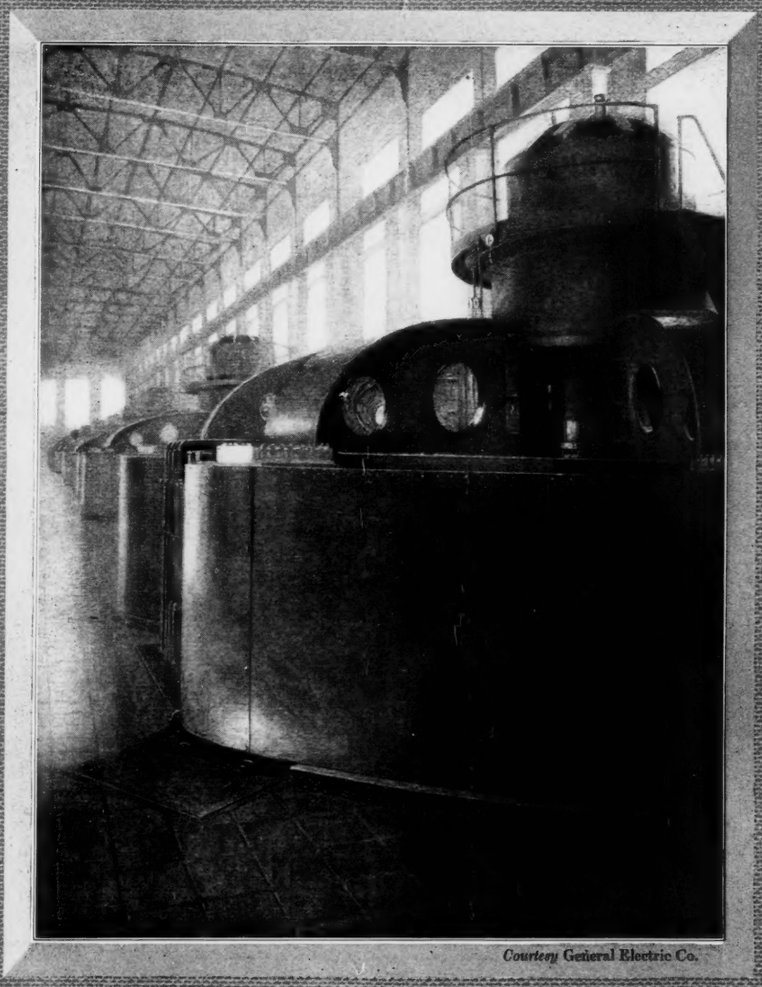

Courtesy General Electric Co.

MASSACHUSETTS
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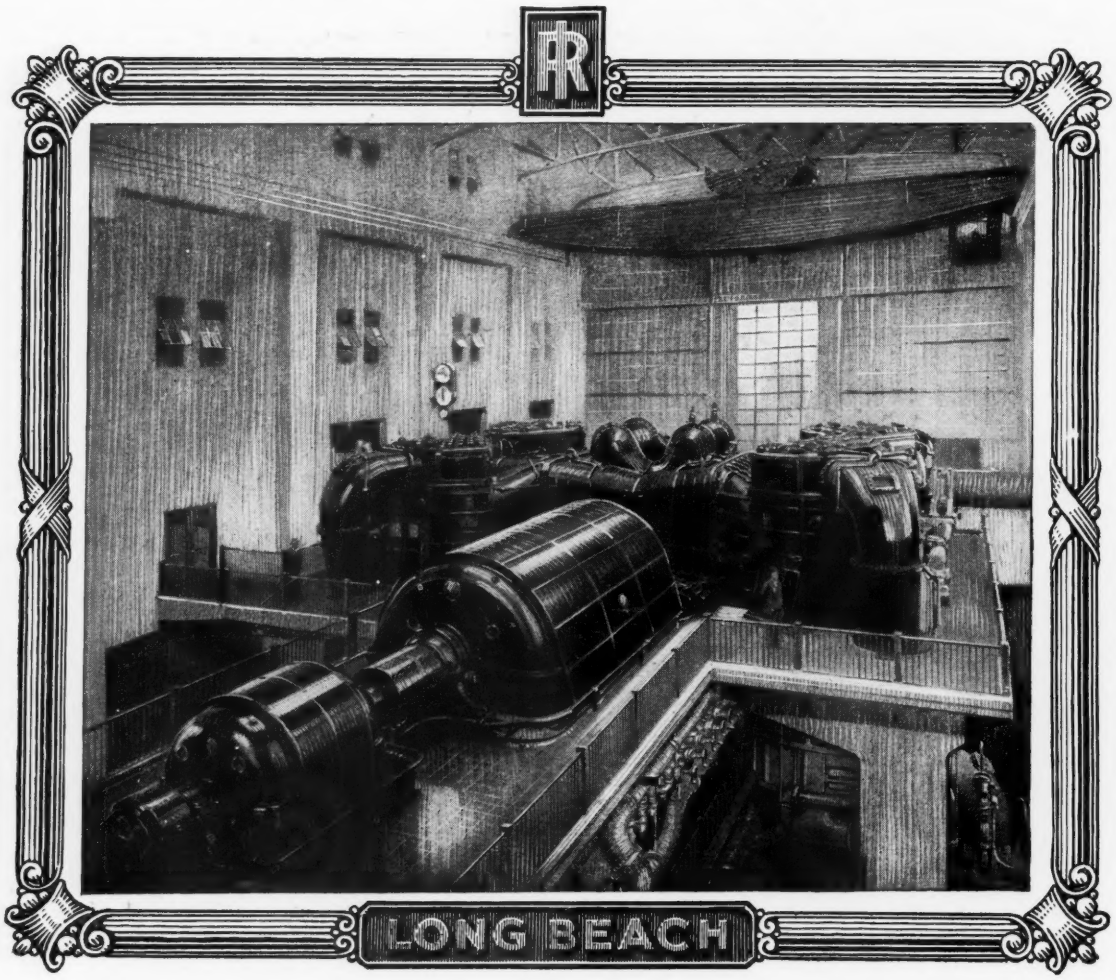
VOLUME XI, NO. 7
DECEMBER, 1930

THE PART PLAYED BY I-R CONDENSERS IN CENTRAL STATION PROGRESS



Four Ingersoll-Rand vertical condensers, having a total condensing surface of 80,000 square feet, serve the 94,000-kw. generating Unit No. 10 in the Long Beach Steam Plant of the Southern California Edison Company. These were the first large-capacity vertical condensers to be arranged for single-pass water circulation.

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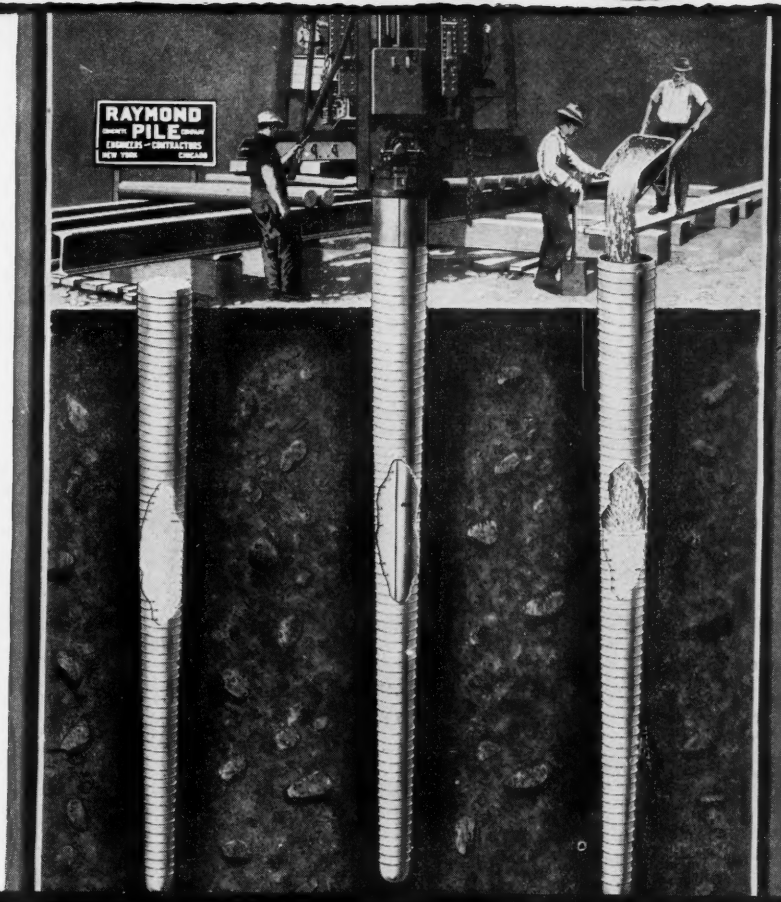

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The TECH ENGINEERING NEWS

Volume XI CAMBRIDGE, MASS., DECEMBER, 1930 Number 7

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New advances in refrigeration

A-E-CO PRODUCTS
Taylor Stokers
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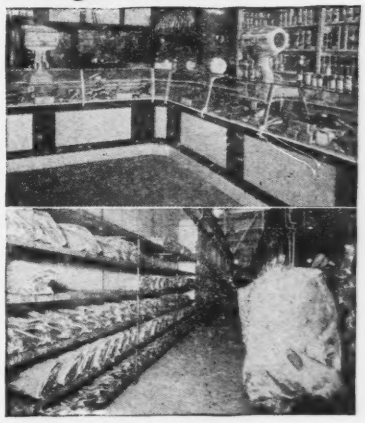
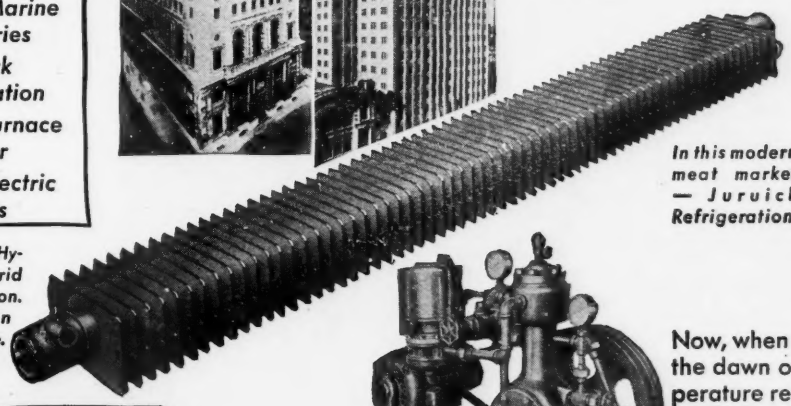
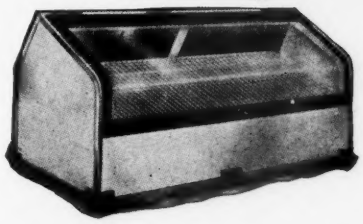
In these buildings — Juruick Refrigeration.

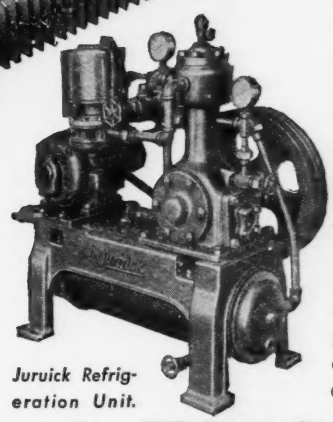


In this modern meat market — Juruick Refrigeration.



At right — New Hydro-thermal grid for heat absorption. Below — Frozen food display case.





Juruick Refrigeration Unit.

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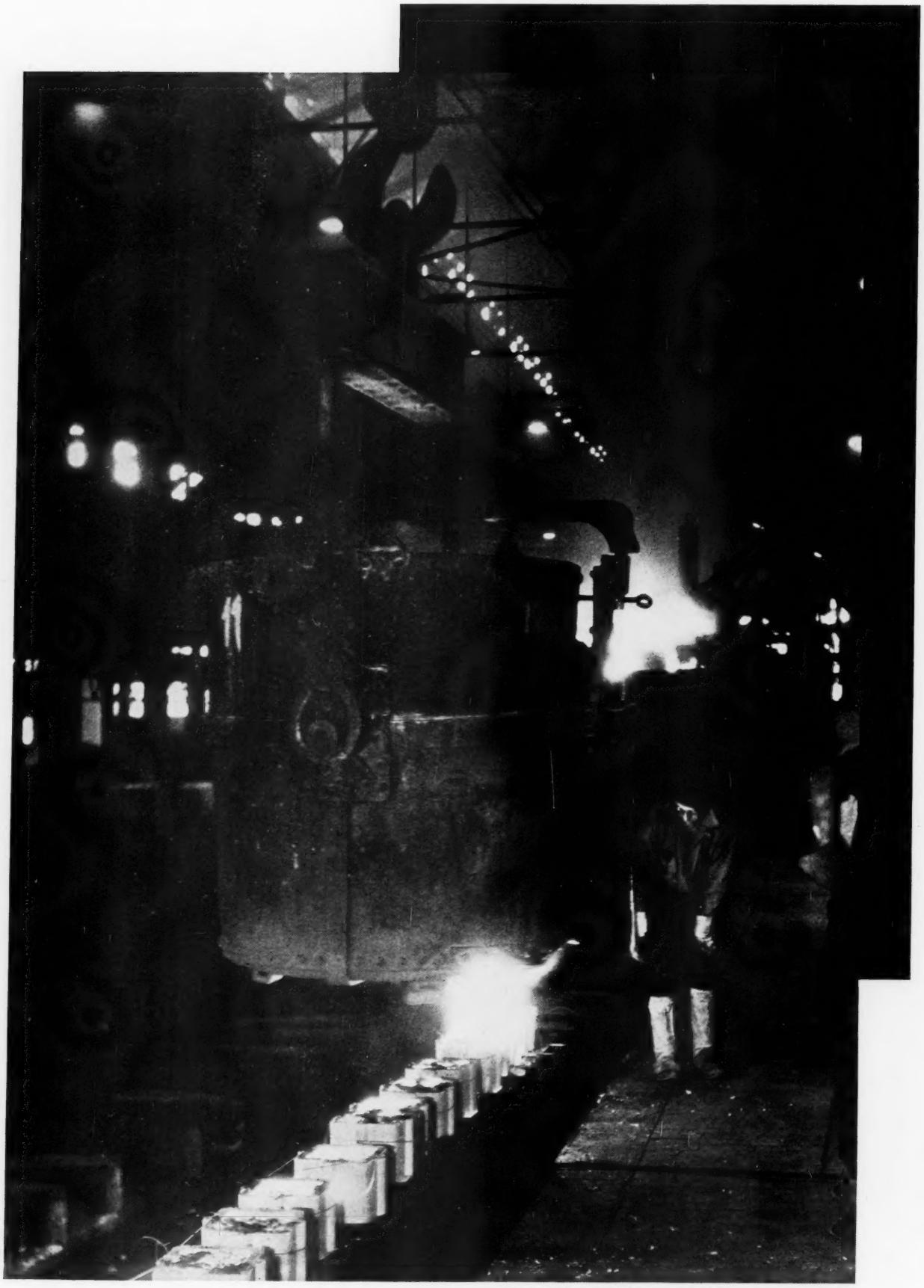


Courtesy *Metal Progress* and Margaret Bourke-White.

Good Steel Starts at the Ingot

THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME XI DECEMBER, 1930 NUMBER 7

The Engineer Guards the Health of the City

BY MAJOR JOEL I. CONNOLLY, '16

Chief of the Bureau of Sanitary Engineering, Chicago Department of Health

IT IS a curious fact that man is more widely scattered over the face of the earth than most other animals. One does not expect to encounter polar bears in tropical jungles nor giraffes among the snows of the arctic regions. Why, then, is man able to live in both regions as well as in the temperate zone between? The answer is simply that man has learned to control his environment and to make it suitable to his needs.

The sanitary engineer of a city is one of the most important cogs in the vast array of machinery which adapts man's urban surroundings to his needs. Except for such services, city life would become impossible, for we would die as a result of epidemics made possible by the close contact with each other which city life necessitates.

The larger the population gathered together in cities, other things being equal, the more complex and difficult become the problems to be solved. In small towns, where everyone knows everyone else, there are left entirely to the conscience and civic pride of individuals many things which appear to require regulation by the municipal authorities in the larger cities.

For example, two problems have recently developed in some of the large cities which are not yet acute enough in small towns and villages to demand co-ordinated action. One of these is the suppression of unnecessary noise. Since the advent of the radio loud speaker of the dynamic type and its extensive use in apartment buildings at all hours of the day and night, as well as for advertising purposes on the streets, many people have become noise conscious. They begin to find that the constant din is making them nervous and irritable and is undermining their efficiency. They turn to the health department to get relief from this newly created or at least aggravated menace to their health and peace of mind, and since the elimination of unnecessary noise is largely an engineering problem, the city sanitary engineer is called in.

The other problem, referred to above, is that of preventing illness and death from large mechanical refrigerating machines installed in multiple dwellings, such as apartment buildings and apartment hotels. Ten deaths and many non-fatal illnesses have been caused in one city by the escape of poisonous gas from such refrigerating systems. Here again is an engineering problem, — that of designing and constructing domestic mechanical refrigerating systems in such a way that at no time will it be possible for enough toxic refrigerant gas to escape to injure the health of human beings.

The increasing use of new processes and chemicals in industrial plants also presents a large and interesting field of activity to the city sanitary engineer, Often new processes are devised which do the work more cheaply, more quickly, or both. For example, the recent discovery or invention of an inexpensive method of manufacturing wood alcohol synthetically, using carbon monoxide, places within easy reach of everyone a cheap but poisonous substitute for grain alcohol. As a solvent in industries, and for many other purposes, such as for an anti-freeze compound in automobile radiators, its use is practically sure to occur in the immediate future. Inasmuch as its vapor when breathed is just as poisonous as when the liquid wood alcohol is swallowed, the industrial use of this synthetic chemical will present another health problem to tax the ingenuity and resources of both the city sanitary engineer and the industrial physician, if the health of the workmen is to be protected in an adequate measure.

Another example of the way in which improvements in doing work may result in hazards to health and even to life itself is afforded by the great increase in recent years of the use of poison gas for destroying household insect pests. Until the last few years, the extermination of vermin was accomplished almost solely by powders and liquids. The greater ease and certainty of killing the bugs afforded by gaseous poisons, such as hydrocyanic acid, has caused a decided trend toward their use. The danger to human life is so much greater with the employment of gas that numerous fatal accidents have occurred and a number of cities have now enacted stringent regulations, the enforcement of which is in the hands of the city sanitary engineer. Usually the fumigators must be licensed and take certain precautions such as notifying the tenants in writing, inspecting the premises before applying the gas, and guarding doors. In Chicago, there were as many as seven deaths in one year before the fumigation ordinance was enacted in July, 1929. Since then there have been none. It is, of course, entirely possible that a fatal accident may occur in spite of the precautions being taken, but the number is unquestionably being greatly reduced.

(*Continued on page 280*)

Sulphur

BY W. L. WHITEHEAD, '13

Special Lecturer in Geology, Massachusetts Institute of Technology

SINCE the first use of gunpowder in warfare sometime in the fourteenth century, sulphur has been of importance to the chemical industry of man. Earliest mining was confined to scattered volcanic deposits of small extent; and not until the discovery of methods of manufacture and utilization of sulphuric acid in England and the consequent development of the Sicilian sulphur deposits did the element become of definite commercial interest. In 1839, with the granting of a monopoly of Sicilian mining to a French Company, English acid manufacturers turned to Spanish pyrites, containing some 48 per cent sulphur, for a part of their needs, and these two sources alone also served American manufacturers in the late nineteenth century. The Sicilian product, mined from beds of limestone and gypsum by shallow underground workings or open pits and extracted by melting in furnaces, was imported to the United States in 1895 to the extent of 165,000 tons. Close control of the native sulphur production and high prices existed, however, in these days and had encouraged American initiative in a search for home sources of the element.

Sulphur had been discovered in 1869 while drilling for oil in the marshes on the Gulf Coastal plain in Calcasieu Parish, Louisiana. Here, at about 600 feet, the drill had encountered sulphur-bearing rock; but the swamps and beds of quicksands below the surface had caused failure of all attempts to sink shafts. The discovery finally came to the attention of Herman Frasch, chief chemist of the Standard Oil Company, and in 1891 he devised and patented a method for extracting the sulphur by wells. He believed that superheated water introduced under pressure into the rocks from the type of well usual in petroleum extraction would melt the sulphur at 239° F. and that the molten sulphur could be pumped to the surface. Before tests could be begun, however, Frasch had skeptics to convince and at last when operations commenced the quicksands again gave trouble in the drilling of wells. Not until 1901, when Capt. Lucas drilled the first successful oil well on the Gulf Coast at Spindletop, Texas, by means of a new rotary method of drilling, were the coastal quicksands easily penetrated. The Louisiana sulphur development then advanced rapidly. Plant design and erection were accomplished and in 1903, after prolonged heating of the ground by hot water, Frasch opened the valves of his pump line and saw molten sulphur flow from the wells.

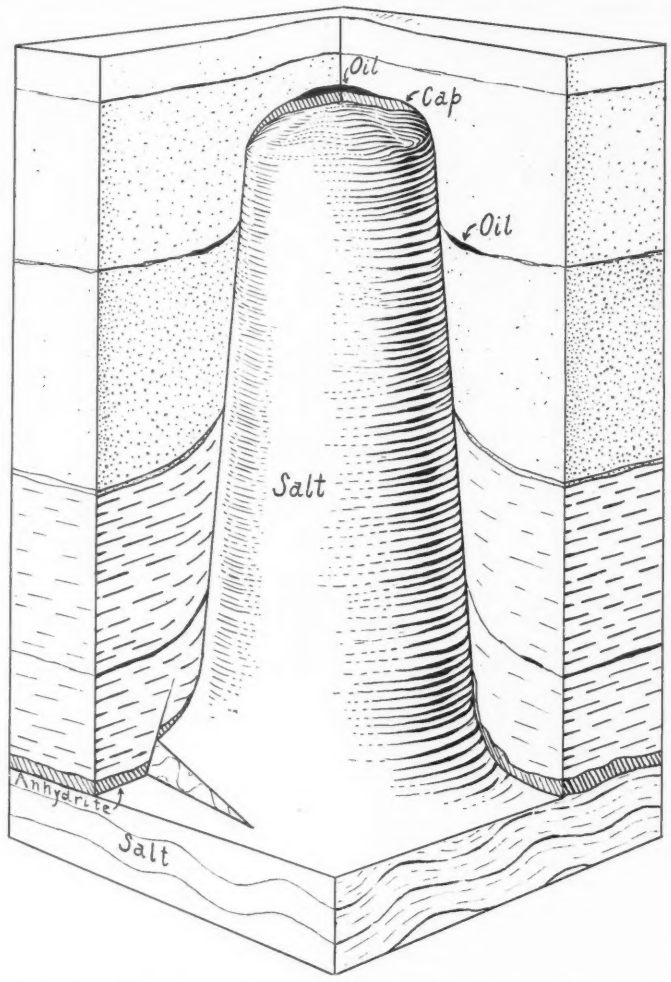


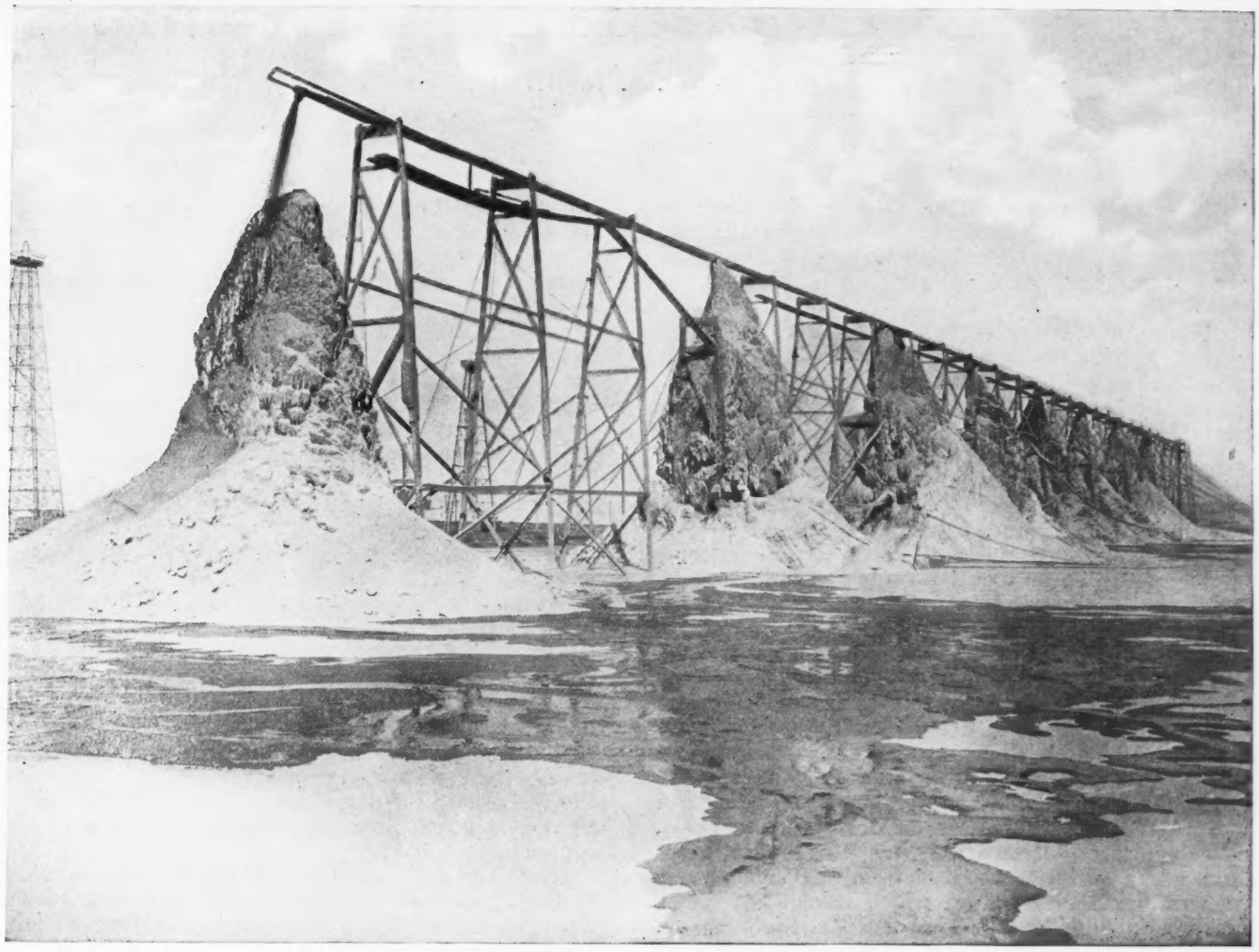
FIG. 1. Diagram of a salt dome. These great domes are from 15,000 to 20,000 feet high and contain sulphur at the top. Oil is found at the same place in pools along the sides of the domes.

The Frasch process as seen today is applied to wells drilled into the sulphur-bearing formation by the ordinary rotary oil drilling rig. The hole is lined with 10-inch casing to the top of the sulphur rock and inside the casing is inserted an 8-inch pipe perforated about 35 feet above the bottom of the hole and opposite the sulphur rock. Again inside the 8-inch pipe is placed a 4-inch pipe resting on a ring inside the former a short distance above the bottom. This ring seals the annular space between the two pipes. A 1¼-inch pipe is let down within the 4-inch pipe to about 200 feet above the bottom of the hole.

To extract sulphur, superheated water, at a temperature of 330° F. and pressure of 125 to 250 lbs. per square inch, is forced down the space between the two larger pipes. This water escapes through the perforations into the sulphur-bearing rock, heats it and melts the sulphur, which flows down into the hole through the perforations below the annular ring. Here the water pressure forces it several hundred feet up the 4-inch pipe from which point it is lifted to the surface by air at 500 lbs. per square inch introduced through the small inner pipe.

At the surface, the molten sulphur is discharged into steam-heated vats and is forced by centrifugal pumps through steam-heated lines and meters to storage bins. These bins are built up by board walls within which the red-brown liquid is discharged (Fig. 2) and solidifies to a bright yellow solid containing 99.95% sulphur. The walls are removed when a height of about 40 feet is attained and the sulphur is broken down by light drills and dynamite. It is finally loaded into cars by steam shovels.

The size of installations in recent exploitations of sulphur may be illustrated by the Bryanmound development in Texas. Here boilers in the plant have a rating



Courtesy Freeport Texas Company.

FIG. 2. Molten sulphur is pumped under pressure from subterranean beds into large vats and by centrifugal pumps from these to the storage bins. When hardened, the huge masses are dynamited apart and loaded by steam shovels into cars.

of 16,800 HP and may be operated at twice the rated capacity. The plant consumes 24,000,000 cubic feet of natural gas and uses about 7,500,000 gallons of specially treated water daily. About 1200 wells have been drilled on this property of 786 acres, including wells used as "bleeder" wells, from which water at 180° F. is extracted from the sulphur rock to control pressure. At the Hoskins Mound plant this water, as well as flue gases and exhaust steam, is used for preheating the 5,000,000 gallons of water per day introduced into the ground.

The great plants of the present sulphur industry of the Gulf Coast are in marked contrast to the small pioneer installation that in 1903 broke the Sicilian monopoly. The methods are still, however, those introduced in Louisiana by Frasch. One difficulty he encountered soon after sulphur was first produced was due to porosity of the rock in which the sulphur was found. The hot water moved so quickly away from the wells that poor extraction of sulphur resulted from the lowered rate of heat transfer. Baled hay, straw, and mud were pumped into the wells, slowed the flow, and permitted increased recovery of sulphur. Mud is now used exclusively for this purpose.

Louisiana has now long ceased to produce sulphur, but new discoveries have been made in Texas to sustain and increase the production on the Gulf Coast. These discoveries have been due to the knowledge of the geology and occurrence of sulphur obtained during the development of the Louisiana deposit and during the intensive drilling for oil in the coastal region which began in 1901 with the discovery of the Spindletop field.

Along the marshy level prairies of the Gulf border in Louisiana and Texas, elevations of only a few feet are visible for long distances. Spindletop was one of these low mounds or domes rising twenty to thirty feet above the plain. It had been drilled with the idea that such eminences had some connection with underlying bodies of salt and that oil might occur in the salt bodies, some of which had been mined in Louisiana. Spindletop proved a large producer of oil and drilling was carried out on many other coastal mounds.

They were found, as expected, to be underlain by salt at considerable depths, but the petroleum occupied cavities and porous areas in beds of limestone, gypsum ($CaSO_4.2H_2O$), and anhydrite ($CaSO_4$) overlying the salt and capping it. Above these cap rocks were the soft sands and clays typical of the coastal belt. The cap rocks and upper surface of the salt were arched, roughly circular in plan, and varied from one-eighth of a mile to two miles in diameter. These structures, the salt domes, are now known to be the cause of all of the sulphur deposits and of most of the petroleum occurrences of the Gulf Coast.

Developments of the last thirty years have given much information regarding these peculiar salt bodies.

(*Continued on page 274*)

Modern Linoleum Manufacture

BY M. E. WADE

Armstrong Cork Co.

IN a quiet corner of the English Cemetery in Nice, France, a simple headstone marks the final resting place of Frederick Walton, the inventor of linoleum, who died on March 16, 1928, at the age of 94.

While America was engaged in the Civil War, this young Englishman happened to notice the thin film which forms on top of an open can of paint. He experimented by combining this tough skin of oxidized linseed oil with ground cork and pressing the mixture on a burlap back, eventually discovering a new material which he named linoleum, a word coined from "linum," meaning flax, and "oleum," oil. Although sixty-eight years have elapsed, linoleum today contains the same three basic materials, mentioned in Frederick Walton's original patent — cork, burlap, and linseed oil.

These raw materials arrive in the United States from all parts of the world to be used in the manufacture of linoleum. Down in the Argentine, the blue-flowered flax provides the seed from which is pressed the linseed oil that eventually finds its way to the linoleum factory. In the swamps of Bengal, India, jute stalks are cut and soaked to loosen the fibres. Then native workers, standing waist deep in swampy water, beat the stalks until the fibre is separated from the waste matter. The jute fibres are dried in the sun, baled, and shipped on battered freighters to Dundee, Scotland, where workmen who have been weaving for years prepare the sturdy burlap which comes across the Atlantic to provide a backing material for linoleum. Before it is accepted, burlap is tested for weight, tensile strength, weave count, and yarn twist. Every yard is watched as it goes into the sizing machine, and must be perfect goods before it is used for linoleum. In the forests of Spain, France, and Northern Africa, workmen are stripping the bark of the cork oak, baling it and hauling it away to be shipped across the seas, until eventually it, too, becomes a part of this floor material invented by Frederick Walton.

When we tour a modern linoleum factory, we see the great tanks where linseed oil is boiling to the consistency of sticky molasses to quicken its oxidization. This boiled linseed oil is pumped into tiny cars that travel back and forth under the roof of a building known as the oxidizing shed, where it is oxidized by exposure to air. In the oxidizing shed long sheets of scrim, a material similar to cheesecloth, hang from the ceiling to the floor. As the car moves along, the oil is distributed to perforated troughs through which it drips down on the scrim. The boiled oil gradually changes its consistency as it comes in contact with the air and becomes a very tough, elastic, skin-like material. In about half a day, another coating of oil will be put over the first one. This will be repeated again and again, for from six to ten weeks, until each cloth has become a heavy sheet of toughened oil, half an inch thick. These sheets of oxidized linseed oil are next ground to a pulp, placed in large kettles, fused with rosin and other gums, and then poured into large cement "basins" to cool.

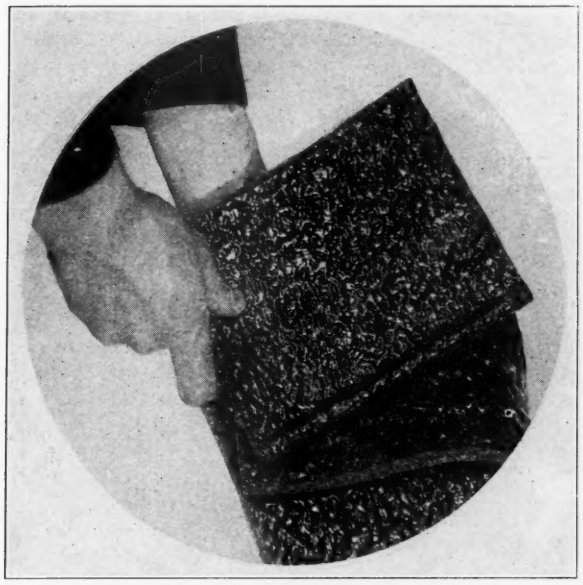
Cutting stencils demands great accuracy as the stencils must match to the thousands of an inch to insure perfect registration of colors.

While this rubbery material is chopped into chunks for convenience in handling, and stored away to age for several weeks, the cork bark, which has arrived from Spain, is being broken up and carried to the top floor of a many-storied building by air suction. As it travels down from the top, the cork is ground and re-ground on each floor between huge millstones weighing 4,000 pounds until, when it is ground for the last time, it has the consistency of a powder so fine that it is sifted through a mesh screen containing 2,500 holes to the square inch.

Now the cork powder is blown through pipes up to the upper floor of another building. As it moves down, the linseed oil and rosin "cement" are ground and, together with the cork powder, it goes down to the mixers on the floor below. The cement and cork powder are brought together here and mixed and remixed on each floor until, when they reach the first floor, they look like brown oily sawdust. On this floor the mix is put upon the burlap back. The rollers in the calender machine force the mix into the burlap back under such great pressure that the two are made practically one piece. The gauge of the finished linoleum is determined by the distance between the two great calender rolls. This can be adjusted accurately to within .005-inch.

The surface of the linoleum is now soft like a very heavy dough. It is easily dented and marked. From the calender machine it goes into huge ovens or stoves. The linoleum is hung from battens at the top of these sixty-foot tall rooms, and falls in great festoons. As each stove is filled, the heat is turned on and the linoleum is left to cure. The time that this "baking" process requires depends upon the weather conditions, the amount of moisture in the air, the thickness of the linoleum, and the make-up of the mix. There is no way of telling when it is finished except by testing it. It must be taken out at just the right time, for, if it is left too long, it may be brittle. The average time is from two to eight weeks, although some batches run longer. In addition, one brand of linoleum is given a special factory treatment that seals the pores and makes it truly easy to keep clean and fresh and new-looking. By a special process, a nitro-cellulose lacquer is forced under air pressure right into the surface of the linoleum. It makes the floor stain-proof and dirt-proof. Grease, fruit juices, and even ink wipe right up.

That is merely the basic method of manufacturing



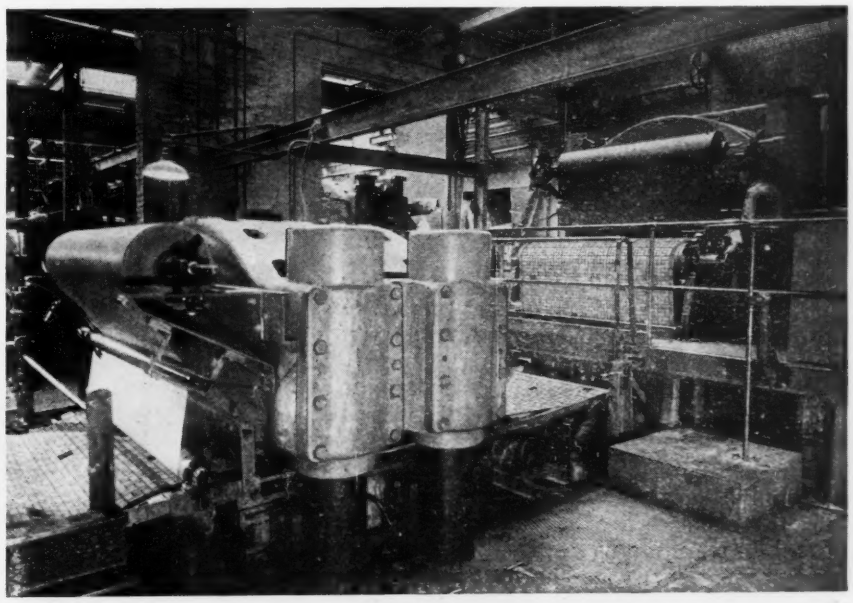
A piece of pure oxidized linseed oil. Notice how flexible and rubbery it becomes.

linoleum. There are many types and varieties on the market today, and each one has its own distinguishing features. In making moulded inlaid linoleum, for instance, skilled workmen painstakingly cut metal stencils for each color in every design. These stencils must be matched to the thousandth of an inch to insure perfect registration of colors. The temperature of the room where moulded inlaid linoleum is made must be kept constant, so that the stencils will not expand or contract. Humidity is controlled, too, because the mix becomes sticky if the air is too damp. After the various colors for the pattern have been placed on the burlap, they are all pressed into one solid sheet by a hydraulic press.

From Walton's day until 1925 all linoleum of whatever type had been perfectly flat. It lacked texture. And then came the invention of embossed in laids, the greatest single advance in the history of linoleum-making. By this process certain types of designs, notably tile effects, are given all the reality of hand-laid or hand-set floors, and yet this new material can be manufactured at a price within reach of all. Embossed inlaid linoleum has proved most popular, and many unusual and beautiful designs have been created to take advantage of this new method of making linoleum more interesting and artistic. Floor beauty has never exceeded that attained by the old master tilers of Europe when they created marble designs that still draw the admiration of thousands. Similar patterns, translated by designers into modern hand-made marble inlaid linoleum, are made by placing the various pieces by hand, and then finally keying them to the burlap by the heavy rollers in the calender machine. Straight-line inlaid linoleum is made on a machine called the rotary press, which makes linoleum while you wait — it takes the linoleum mix, makes it into a blanket, cuts out the pieces, fits them together upon the burlap back, and calenders the linoleum. Without a doubt, this machine is well worth the years of time taken to perfect it, and more than the million dollars it cost to install. This machine is based upon Walton's original invention.

Printed linoleum, too, is made by a fascinating process. The plain-color linoleum is fed into great printing presses, where hand-cut pattern blocks, each one coated with a different colored oil paint, impress the design on the surface as it moves along, until it finally reaches the great stoves to dry out before being crated and shipped.

Thus this product, manufactured out of materials which come from many lands, is ready to be shipped to retail stores, where it can be bought at reasonable cost, to bring comfort, cleanliness, and charm to homes. Just as we saw all the world join in the making of linoleum, we now see every land and country claim its share of the finished floors. The love of beauty knows no political boundaries, and the desire to bring beauty into the home exists regardless of race, creed, or clime. Linoleum is being featured today as *the* imported floor in the style centers of Europe — London, Paris, and Naples. Nomads of the Gobi Desert buy quantities of it from a trading company of Manchuria. It goes by train and steamer, by mule-back and river boat, taking beauty to the earth's far corners.



This embossing press gives the linoleum texture by pressing part of the design below the rest so that certain blocks stand out.

Sunlamps for Health Building

BY L. C. PORTER

Illuminating Engineer, General Electric Co.

ALL life — plant, animal and human — has evolved under natural sunlight, and in the last analysis is dependent upon the sun for continued existence. To obtain an adequate amount of natural sunshine is becoming an increasingly difficult task. Our modern living conditions are driving us indoors. People are deserting the healthy outdoor life of the farm and spending their time in offices, factories, homes, places of recreation, and even automobiles enclosed in glass. Even the animals and domestic fowls are going through the same evolution. Today, instead of every home raising a few hens in the back yard, eggs are hatched in incubators, chicks are raised in lots of 5000 to 100,000 in battery brooders, and the hens kept in artificially heated, ventilated and lighted henhouses designed purposely to keep them off the ground and indoors. Even the cows have their outdoor periods cut to a few hours per day and spend the rest of their time indoors contacting with such things as vacuum cleaners and electric milking machines.

Such are the demands of mass production in off-season periods! Perhaps these changed living conditions can best be realized by noting that one of our large industries is now constructing a new factory which will have absolutely no windows — no daylight whatsoever. It will be artificially lighted, heated, ventilated and humidified.* Man, however, is ingenious and intelligent. He has realized that depriving living things of their normal quota of natural sunlight is not beneficial. Studies have been made to determine what it is in sunshine that is of benefit and how it reacts on living things. These studies showed that of the enormous range of wave lengths in radiant energy coming from the sun (Figure 2) a very narrow band was of maximum benefit in maintaining health, i.e., ultraviolet energy between the λ2800 and λ3100 (λ = 1 Angstrom Unit, A°, = one ten-millionth of one millimeter. 25 mm. = 1 inch). Probably other wave lengths have some beneficence, but those between λ2800 and λ3100 are particularly useful for maintaining health. This narrow band has its maximum at λ2967, as shown in Fig. 2. Unfortunately, ordinary window glass transmits practically no ultraviolet in the health range. It is for that reason that as we coop ourselves up indoors it becomes essential to make up this deficiency of the vital rays. Even if we do spend considerable time outdoors in the wintertime there is a very small amount of ultra-violet in natural sunlight and in this latitude relatively little sunshine.

To meet these conditions various types of artificial sunlight generators have been invented and marketed. Until recently the two types in most common use were the carbon arc and the quartz mercury arc. Each of these, in addition to generating the healthful ultraviolet between λ2800 and λ3100, also generated short wave radiation. This short wave energy is useful for certain purposes, but is dangerous for the layman to play with. For example, radiation at λ2537 can cause severe conjunctivity of the eye. To protect against this, operators of these high-power ultraviolet sources wear dark-colored glass goggles and patients being treated with the lamps take similar precautions. For these reasons the use of such lamps has in the past been largely confined to treatment under physician's direction. It has been the dream of research laboratories for a number of years to produce an ultraviolet source for the maintenance of health rather than the treatment of disease; a source which would be safe for use by the general public in the home, and one which would have the simplicity of operation of the ordinary Mazda lamp and would be sufficiently low in cost to make it available to the general public.

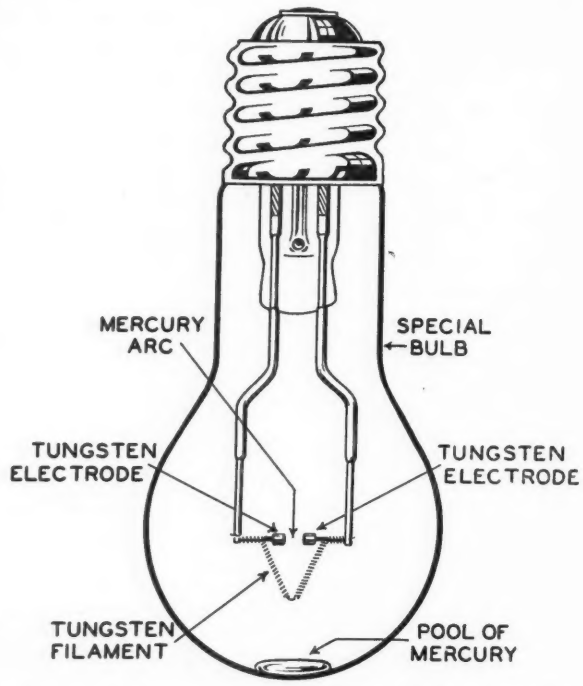


FIG. 1. The Sunlight lamp consists of a mercury arc between tungsten electrodes at the terminals of a tungsten filament. The bulb contains argon and a pool of mercury which supplies mercury vapor for the arc.

After many years of experimental work, a lamp meeting those requirements has been developed and put on the market. It is known as the Sunlight Mazda lamp. (Fig. 1). This new lamp consists of a "V"-shaped tungsten filament, two tungsten electrodes and a pool of free mercury enclosed in a bulb of special glass. When the current is turned on, the filament is heated to incandescence, drawing approximately 9½ amperes at 30 volts. A part of the mercury is vaporized and an arc is formed between the electrodes at that instant. The characteristics of the special transformer from which this lamp operates immediately drop the voltage to approximately 10½ and increase the current to 30 amperes, at which value it continues to operate. The special glass of which the bulb is made absorbs or filters out the short wave radiation below λ2800 so that the remainder or transmitted energy contains only the most desirable ultraviolet, closely approximating the light from midday, midsummer sun. It is from this light that one gains the outdoors coloring and feeling of vigor similar to that which one notices under summer sunlight.

*Editor's Note: – See the article on the Windowless Factory in this issue – page 264.

Due to the absence of short wave radiation, it is not necessary to wear goggles when using this lamp. However, the same care should be used with the lamp as would be exercised on the bathing beach. Exposures should at first be of short duration, say 10 to 15 minutes (at a 30″ distance from the lamp), and gradually increased as one becomes accustomed to the ultraviolet or as a protective coat of tan is developed. Commercially, the lamp is available in two general types, each of which contains the transformer, switch, and special reflector of oxidized aluminum designed to efficiently reflect ultraviolet radiation. (Many surfaces, such as porcelain, enamel, silver, etc., which are excellent reflectors of visible light, are very poor reflectors of ultraviolet energy.) (Fig. 3). One type is a floor stand unit for general use in the home and the other an overhead unit for use in such places as gymnasiums, swimming pools, indoor golf courses, and in dairies and poultry houses. The complete unit consumes approximately 425 watts and can be operated from any 60 cycle, AC circuit between 105 and 125 volts. If it is desired to use lamps on other frequencies such as 25 or 50 cycle, special transformers are available for the purpose. For direct-current circuits, it is necessary to secure a small motor generator set or a rotary converter to change the direct current into alternating.

Perhaps it may be worthwhile to indicate the basis of dosage with these lamps. The most commonly known benefits are the cure and prevention of rickets in babies. Many doctors have used as a basis of treatment for the cure of rickets exposures to ultraviolet lamps which will produce an erythema, or reddening of the skin. (This does not show up until several hours after the exposure.) On that basis, Doctor Luckiesh, director of the Lighting Research Laboratory of the General Electric Company, has determined the minimum exposure to various ultraviolet sources which will produce a barely visible reddening of the skin, or as he calls it, minimum perceptible erythema. He has found that this is a product of the intensity of radiation and the time of exposure. It can therefore be expressed in footcandle minutes. The values for various sources are as follows:

Midsummer, noonday sun..... 180,000 fc. m.
Mazda Sunlamp (at 30″ distance) 4,000 fc. m.

Noonday sunlight may run as high as 9000 or 10,000 footcandles intensity; whereas, the Sunlamp at 30″ has

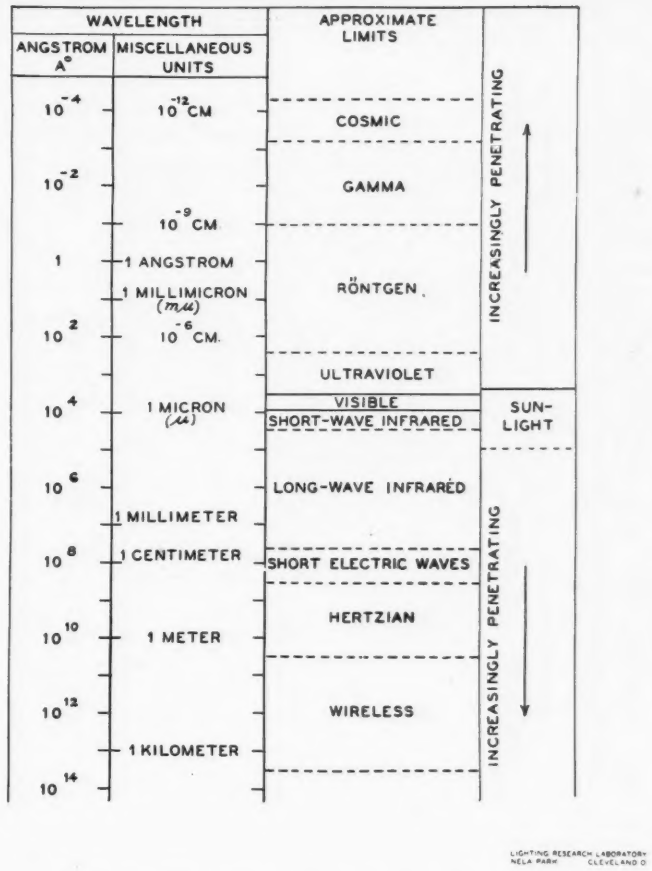


FIG. 2. The entire range of spectral energy which has been studied from both natural and artificial sources. The wavelength scale is logarithmic.

an intensity of approximately 400 footcandles. It is, however, much richer in ultraviolet per footcandle than sunlight, so much so, in fact, that at 30″ an exposure of 8½ minutes to the Sunlamp is the equivalent of a 20-minute exposure to noonday midsummer sunlight. Exposures of 21 minutes to the Sunlamp on average untanned skin should produce vivid erythema, or moderate tan. 42-minute exposures would produce burn and 85 minutes, blistering. Research work conducted on rats and chickens has shown clearly that much less ultraviolet is necessary to prevent than to cure rickets. Probably intensities or exposures of the order of 25% of a curative dose are all that are necessary to maintain health. On that basis, it has been found that the use of the Sunlamp (overhead type unit) in chicken houses produces remarkable results; such, for example, as

(1) preventing the loss of baby chicks from rickets;
(2) production of larger pullets in a given length of time;
(3) increase in egg production;
(4) increase in size of eggs;
(5) increase in vitamin D content of the egg, therefore increase in its food value;
(6) decrease in loss of eggs due to breakage from thin shells;

(*Continued on page 278*)

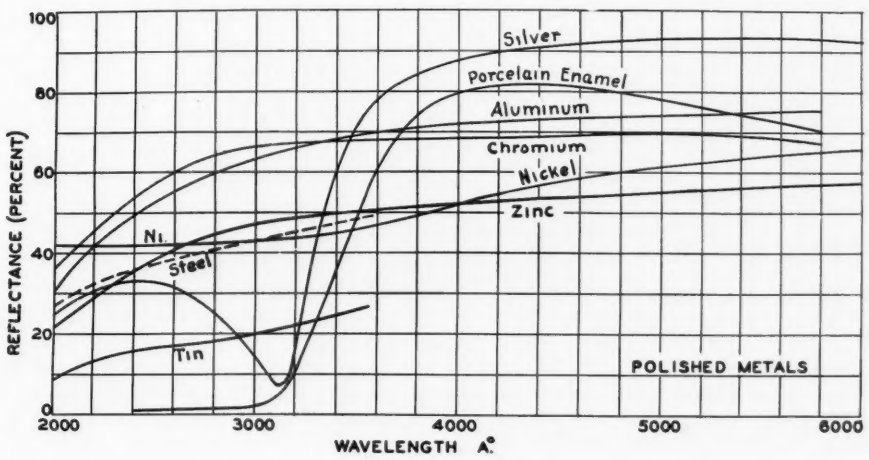


FIG. 3. The percentage spectral reflectance of polished metals at varying wavelengths.

Windowless Factories

BY JOHN W. HILL

WINDOWLESS buildings have been discussed for some years and in Germany a large movie studio has been constructed without windows. But the proposed Simonds factory at Fitchburg, Mass., will be the first time that industry has undertaken to put the idea in practice. The use of a windowless building requires two things. First, artificial light, and second, mechanical ventilation. For this building systems are being designed for illumination and ventilation which it is expected will be superior to the lighting provided from daylight through windows and skylights.

In planning the building, every factor affecting the five senses of human beings has been studied and analyzed with the utmost scientific care, to the end that conditions will be created that will be most ideally conducive to comfort for operatives, and consequently greater efficiency.

One of the important features will be noise absorption through accoustical walls, ceilings and other means. The visibility of the machines will be lifted through the innovation of orange-colored paint for equipment. Experiments conducted by the company have indicated that an increase in efficiency by as much as 33 per cent may result from the new methods, which will tend to reduce noise, fatigue and nervous strain.

The conditions of the plant will permit the operation of two shifts daily, with the result that the company may produce a given amount of output with an investment equivalent to one-half the amount that would be required for the ordinary factory designed for one daytime shift. This phase of the new building is attracting wide attention among industrial executives, offering as it does a revolutionary method of reducing overhead costs. The Simonds experiment and its results will be closely watched by industry throughout the country.

Under ordinary working conditions in a factory illuminated by daylight, the light is changing constantly so that it is for periods of short duration only that each machine, desk or bench receives the kind and amount of illumination best suited to the eye and which enables the workers to produce with the least strain and effort. Natural light is constantly varying in intensity, due to clouds and changing weather conditions. It will concentrate close to the windows, and other parts of the building may be in semi-darkness.

With respect to the ultra-violet light derived from sunlight coming into the buildings, operating under natural light, many tests have showed that it is on certain days only that there is sufficient ultra-violet light in sunlight to be effective and that this is lost by absorption in the window glass.

In a great many manufacturing plants with windows proper care is not taken to keep them clean, with the result that the light efficiency is cut down to an alarming degree.

Lighting

In the new plant, lighting will be accomplished by means of 1000-watt lamps mounted 18 feet above the floor line and enclosed in special steel diffusing shades giving a uniform light intensity of 20-foot candles on the working plane. This intensity promotes the ability to see and the speed of vision, thus reducing the hazard of accident. By the introduction of some ultra-violet in the lighting system, a germicidal action beneficial to health is obtained.

Provision has also been made so that in case the power should fail at any time an emergency lighting system, operated by storage batteries, would automatically be thrown on.

The lighting system providing one sheet of light of equal intensity over the entire building is expected to make it easier to achieve uniform quality of product. A small percentage of light from the lamps will be reflected above to the ceiling, for the purpose of creating a more cheerful atmosphere in the building and assist in the general diffusion of light.

Ventilation

Next to the problem of lighting, that of ventilation is the most important in the design of the building. Every precaution has been taken to insure the health and comfort of employes. Through automatic humidity control the moisture content of the air will be kept at the point most beneficial to health. Temperature also will be controlled and every 10 minutes over 500,000 cubic feet of air tempered to right condition and cleansed of dust and other outdoor impurities by washing and filtering will be brought into the building, making a complete change.

In hot weather the air will be cooled through evaporation by atomized spray bank. In cold weather the air will be heated through coils, in auxiliary fan houses, through which the air will pass after washing. The air will be delivered to various sections of the building through ducts. The heating system will be under thermostatic control. All fumes, gases, exhausts and excess heat are removed from the building by underground ducts.

Special study has been given to the problem of eliminating draughts, and fresh air is so delivered that employes will feel only the freshness of a slowly moving body of air. By control of humidity in winter a great deal of usual trouble from colds and similar diseases will be avoided.

Noise Reductions

In order to lessen the nervous tension and distractions incident to modern factory din, extensive study has been made in search of a solution of the problem of noise reduction. The result is to be accomplished in a number of ways, through acoustical walls, ceiling and floor, through the isolation and padding of large machines and drop hammers, and by actual silencing processes.

The floor will have a concrete base with an acoustical wood block for such portions not occupied with equipment foundations. Machinery causing noise and vibration will be isolated from the body of the floor and cushioned with cork pads.

Noises from material in process of manufacture will be reduced by masking, tempering and dampening. The process of masking allows different noises of similar frequencies to counteract each other, while the process of tempering involves placing shields in machines

(*Continued on page 273*)

Antifreeze Solutions for Automobiles

BY AUGUSTUS H. GILL, '84

Professor of Technical Chemical Analysis, Massachusetts Institute of Technology

AS THE name denotes, antifreeze solutions are liquids used with gas or gasoline motors to protect them from damage by freezing. The conditions that such a coolant should satisfy are:

First: Low freezing point and high specific heat.

Second: Inactivity as regards metal, packings, rubber, etc.

Third: Permanence as regards evaporation or the effect of heat.

Fourth: Cheapness.

The substances used for this purpose may be divided into inorganic and organic classes, of which the former were among the first used.

One of the earliest was an aqueous solution of calcium chloride, which satisfies all of the above conditions except the second. Calcium chloride solution, even if properly made, is known* to corrode the iron of the cylinders, the solder in the radiator, and aluminum pumps and headers, the action upon the two latter being serious. A chromate may be used to prevent this action, except in the case of contact with aluminum parts.

Another disadvantage is that when the solution comes in contact with ignition wires and spark plugs it keeps them moist, making short circuits and leaks of electricity. The solution seeps through packings and gaskets and concentrates by evaporation, thus producing drops which smear and corrode metals.

Besides this, a further difficulty which proved the chloride solution impractical is that it contains magnesium chloride. This substance breaks down at the boiling temperature, yielding hydrochloric acid, which acts vigorously on all metals concerned, and particularly on dissimilar metals in juxtaposition.

Other Salts. Even if shown to be without action on metals, other organic salt solutions would probably affect ignition wires and spark plugs, causing short circuits and faulty ignition.

Organic Coolants.

The following have been suggested: —

Honey or similar substances,
Petroleum oils,
Alcohols.

Low-grade Honey or *similar substances*, including sugars and glucoses: these are all liable to carbonization by the hot walls of the cylinder. If they are used in sufficient quantity to prevent freezing, they are so viscous that circulation almost stops; if the solutions be sufficiently dilute to circulate well, they freeze too easily and cease to protect.

Percentage composition by volume of the different coolants in aqueous solution to withstand freezing at certain temperatures and their approximate prices:

Temperatures °F	Wood Alcohol (Methanol)	Denatured Alcohol	Ethylene Glycol	Glycerine
30°	..	..	..	..
20°	12	19	16	22
10°	20	30	25	32
0°	29	38	32	40
— 10°	34	45	39	47
— 20°	40	52	44	54
Price $ per gallon	0.48	0.43*	2.66*	1.90

Petroleum Oils. Kerosene has been used as a coolant; it attacks rubber packings very considerably, particularly when warm and, having a specific heat about half that of water, is inefficient to that extent. Furthermore it increases the fire risk, three or four gallons of hot or boiling kerosene not being a desirable neighbor in case of leakage or head-on collision. Furnace oil, a "higher boiling" kerosene, has been used occasionally with some success.

Alcohols

Under this heading are included methanol or wood alcohol, denatured alcohol (possibly propanol and butanol in the future), ethylene glycol, formerly commercially known as "prestone," and glycerol or glycerine.

Alcohol is made by fermenting molasses or glucose and distilling the mash thus obtained. It is denatured with wood alcohol or methanol and preferably nothing else. Some formulae for denatured alcohol contain a small quantity of mineral oil or similar substance. This, when diluted with water, is precipitated, more or less emulsified, and adheres to the cells in the radiator, thus diminishing their heat conductivity. Unless the wood alcohol be carefully purified, it may contain acetic acid, which will corrode the metals. Alcoholic mixtures are cheap and have little or no action upon metals, rubber or packings, nor do they seep through packings. Alcohol has the disadvantage of low boiling point (172° F., 78° C.), which means that solutions containing it lose considerable of their volume when boiled or heated nearly to the boiling point, necessitating frequent replacement. They do act, however, on the lacquer finish of the car.

With alcohol, and probably with all organic coolants, no solicitude as regards the breaking of the cylinder block or bulging of the radiator need be felt if at least a 6 per cent solution be present. If we consider for a moment the phenomenon of freezing, we find that the frozen mush is made up of plates of ice mingled with a liquid richer in alcohol between them. The freezing out of those plates of ice has of course made the mother liquor stronger in alcohol. Consequently we have the liquid in the condition of mushy snow, the plates of ice alternating with alcohol slipping by one another and preventing the dangerous expansion of solid ice, which damages the metal parts.

The writer has exposed flasks in the shape of truncated cones, resting on their bases (Erlenmeyer flasks), containing water and 6 per cent denatured alcohol to temperatures of 40 below zero F. (— 40° F.) without bursting the alcohol-filled one; those containing water or a

(*Continued on page 278*)

*Bureau of Standards Letter Circular L. C. 28 (1925).

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Editorials

LEONARDO DA VINCI

Newcomers to Technology and visitors to our buildings frequently wonder why the name of Leonardo da Vinci has been inscribed on one of the pylons along with those of men like Galileo, Newton, and Aristotle.

Leonardo is best known to the world as a painter, architect, and sculptor, but he holds his position on Technology's walls because he was one of the greatest engineers of all time. We have the picture of him in the late fifteenth century, a silent and solitary figure, habitually attentive and exact, carrying his inevitable notebook in which he made sketches and recorded his observations of men and science. He dressed modestly, but his imposing appearance made him stand out above the other people of his time.

He realized that there was an uncrossable abyss separating him from most of his contemporaries, but he disregarded political events of his time, realizing the eternal serenity of nature. His life consisted of a series of lonely and despondent wanderings from place to place, with a fearful, everlasting solitude to bear. Holding himself aloof from all women, he never married. With a kindred spirit, Machiavelli, he felt more free to express himself. Even this friendship might have dissolved had Leonardo understood more about politics.

What do we know of his accomplishments outside the field of art in which he gained his greatest fame? He was ever striving toward the unattainable, trying always to reconcile art and science, inspiration and mathematics. Fragments and isolated notes, written from right to left, with reversed characters, leave us a record of many of his works, although not a line of his was printed during his lifetime. The greatest discoveries in mechanics since the time of Archimedes must be credited to Leonardo. In his span of sixty-seven years he crowded original study and research in natural history, anatomy, astronomy, mathematics and physics. He studied fossils and geologic formations, wave motion, and resonance; made barometers and dug canals. His work in hydraulics and civil engineering overshadowed his military engineering, but he designed the forerunner of our modern war tanks.

During his entire life he studied the flight of birds and attempted to design a flying machine. He realized the inevitability of flying and once said, "There shall be wings. If not I, then some other man shall invent a machine that shall enable him to fly." His quickly forgotten grave was soon level with the earth and memory of him vanished rapidly; but within the last century a revival of his works and notes has shown that he anticipated many men who later received the credit for various scientific discoveries and statements of physical principles.

DRUDGERY IN ENGINEERING

There is apparently quite a bit of controversy about the exact aim of engineering education. The popular conception is that a technical school turns out a sort of superman, one who stands proudly upon vast expanses of concrete and steel and "throws down the gauntlet to the elements." The more intelligent, but nevertheless idealized, idea held by the business men who employ engineers is that a technically trained man is one who is able to grasp a problem and attack it in a scientific way. He sizes up the method of attack, marshals a theoretical corps of assistants and, much in the style of Edison, commands the job to be done. In support of this conviction is the fact that a great many Tech graduates never practice in the profession they are trained for. Their claim is that the particular course pursued is not as important as the manner in which it is pursued. Mental training is the thing; broad principles and ability in generalship are the essentials for success.

To the harassed student, technical education is quite a different thing. He is soon convinced that he is slowly becoming a thinking machine, capable only of skillful manipulation of slide-rule, log tables, formulae, and dull routine. The intricate and lengthy solutions of integral forms in calculus, the senseless problems in physics, the deadly routine of qualitative analysis, all combine to show him that the larger proportion of technical training is drudgery, pure and simple.

An engineer, especially a young man starting on his career, is expected to produce results, not long discourses on ways and means. The problem is stated, the solution must be forthcoming. The financier or the contractor cares little for method; he wants his job done. Hence the emphasis in technical education on drudgery and routine, by which the desired results are produced. The American tendency toward a short cut for everything under the sun will not work in engineering. Half measures never fill the bill.

It is quite true that leaders in engineering today do not necessarily concern themselves with detail. In their case, the "corps of assistants" is not theoretical; it actually exists. But the "assistants" are young engineers, and to them comes the mass of routine operations. And in nearly every case the man at the top has at some time in his career been forced to accept drudgery at its face value. As an example, the chief engineer of construction of the new Hudson River bridge cannot remember, offhand, the height of the towers he is erecting or the number of strands in the cable he spins. But in his early experience he was certainly concerned with the annoying details of his work. Now he works at the peak of his profession; he builds a path in steel.

So there is hope for all of us who hate drudgery. We may advance far enough in the ranks to be rid of our figures and slide-rule. But only when we shall have faced the figures, gained a respect for the daily routine, the slide-rule and the formula, shall we be competent to enter the ranks.

ELECTIONS

We have the pleasure of announcing the following elections to our staff: in Editorial Department, J. D. Fales '34, E. R. Carr '34, C.B. Gamble '34, W. R. Haselton 34, E. L. Jones '33, F. H. Moore '34, C. T. Stewart '34; and in the Business Department, J. G. Borger '34, R. M. Elliot '34, C. E. Fulkerson '33, F. M. Hartz '34, D. B. Ingalls '34, G. E. Merryweather '34, W. F. Read '34, J. B. Wadhams '34.

Bachrach

PROFESSOR DUGALD C. JACKSON

Head of the Department of Electrical Engineering

Professor Jackson is widely recognized in America and abroad as a leading authority on electricity, not only as a consultant, but as an educator as well. His experience in this field has built for him a reputation which extends beyond the professional into civic life, and led to his selection as a delegate to the World Engineering Conference representing the United States Government last year. A brief summary of his career should prove of value to those who are unfamiliar with his achievements.

Professor Jackson was born in Kennet Square, Pennsylvania, in 1865, and received his early education at Hill School, Pottstown, Pennsylvania. His first professional training took place at Pennsylvania State College, from which he graduated in 1885 in civil engineering. Two years of graduate study in electrical engineering at Cornell prepared him further for his professional work, and soon after he became an executive and engineer in a Western engineering concern.

Four years after leaving Cornell he became Professor and Head of the Department of Electrical Engineering at the University of Wisconsin at the time that Department was established. He remained in that position from 1891 to 1907. From Wisconsin he came to M.I.T. as Head of the Electrical Engineering Department, which position he has held for nearly a quarter of a century. This year marks, therefore, the fortieth consecutive year he has served as head of an Electrical Engineering Department. During his long career as a professor, Professor Jackson has become a leading authority in the consulting field, and is in wide demand for this purpose throughout the electrical industry. The installation and improvement of many leading electrical railway and long distance power transmission projects have taken place under his direction.

His work in the Department of Electrical Engineering at the Institute has resulted in building one of the strongest schools in this field in the world. The divisions within the Department, the Co-operative course with industrial concerns and the revolutionary Honors Group plan now in use in the Department, are outstanding features which have come into being under his leadership.

During the World War, Professor Jackson assumed the rank of Lieutenant Colonel in the Engineer Corps. His work in military engineering won him the decoration of Chevalier of the Legion of Honor of the French Republic.

He is author of many books and papers on electrical engineering. Among them are: "A Textbook on Electricity and Magnetism and the Construction of Dynamos" (1893), "A Series of Lessons on Electricity and Magnetism," as joint author: "Alternating Currents, and Alternating Current Machinery," and "Street Railway Fares — Their Relation to Length of Haul and Cost of Service." He has also written many papers on electrical engineering and education for the leading technical journals.

He is a fellow of the American Institute of Electrical Engineers, and president of this organization from 1910 to 1911. He is a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the American Physical Society, and a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Consulting Engineers, and societies in London and Paris.

He has been senior partner in a well-known firm of consulting electrical engineers, from which he retired on reaching the age of sixty-five years. Granted leave of absence last year to attend the World Engineering Conference, he has now returned to the Institute, and resumed his duties with the vigor that has characterized his entire career.

Engineering Notes

The 1,652-Foot Steel Arch, the longest yet built, of the Kill Van Kull bridge between Bayonne, N. J., and Port Richmond, Staten Island, N. Y., was closed 250 feet off center. Closure off center had to be effected on account of restrictions against constructing falsework in the ship channel of the Kill Van Kull River. Forty panels, each forty-one feet, three and three-eighths inches long, were used in the arch. These were erected by the cantilever method from ten steel falsework bents placed and released successively as the erection progressed. Construction of a first arm was started on the Port Richmond side of the river and carried out fourteen panels, after which the erection traveler, operating on the top chord of the panels, was dismantled and moved to the Bayonne side of the river, from which the erection of a longer second arm to meet the first was begun. As cantilever erection progressed the load was transferred from each falsework bent to the one beyond by means of jacking, with jacks placed at alternate bents, either at the top of the bents or in the shoes. When the point of closure was reached the cantilever arm from the Bayonne side was 413 feet long, with an anchor arm of 661 feet.

A sixteen-inch diameter pin was used for centering the lower chord members of the arms as they came together, with a clearance of one inch being provided between the ends of the chords to facilitate easier closure. When the arch was ready for closure there was an opening of about twelve inches. An arrangement for taking measurements was devised whereby the movement of the arms as they were lowered into contact could be checked and the arms kept on their proper course. The actual error in the horizontal alignment of the arch trusses as they came together was less than an inch.

Transportation of Invalids has been aided by the design of a new Pullman car. Besides the regular platforms at the ends of the car, there are, in the side, three doors for the direct entrance of stretchers. Two of these doors open directly into the room which the patient is to occupy, while the third gives access to the open sections of the car interior. Each car contains eight open sections, one drawing room and four rooms, each of which contain a stationary bed and an upper berth for an attendant.

Particular attention has been given to the elimination of the noises of travel. The cars are equipped with roller bearings, and rubber insets have been placed between the trucks and body of the car at points of contact. The diaphragms at the car ends are spring-hung from the top, thereby greatly reducing the amount of car-end rattle.

In addition the car has many special features to aid this special service. All corridors have been widened to accommodate either a stretcher or a wheel chair. Arrangements have been made for the use of many electrical devices, such as heating pads, etc.

A Mobile Multiple Machine Gun Mount, which is being tested by the army, is composed of a standard 5½ ton chassis and four .50 caliber machine guns with fire-control apparatus. It is intended primarily for anti-aircraft work.

The truck has six wheels with two pneumatic tires on each wheel. One tire to each front wheel is two inches greater in diameter than the other. Thus easy steering is provided on solid ground and only one tire is in contact. On soft ground, however, the smaller one aids in bearing the load.

The firing platform, which has a traverse of 300°, contains the water-cooled machine guns, a stereoscopic height finder, and a data computer. The guns are mounted in parallel and all are aimed together. The ammunition is in links and is fed to the gun through chutes.

Courtesy Army Ordnance

This mobile unit has four machine guns, all of which are aimed together. Note different size tires on front wheels.

Electrically Operated Brakes for automobiles have been found to give very satisfactory results. This type of brake was developed to provide an external aid in applying the pressure. It consists chiefly of two parts — an electromagnet and an armature. The armature is in the form of a steel disc and is attached to the revolving brake drum. Its face is in constant but very light contact with that of the magnet. The latter is also a disc, with the coil sealed in a ring along its circumference. When a current from the battery is passed through the coil, a tremendous attractive force is built up between the magnet and the armature, and the former also tends to revolve. However, a lug on its rim pushes against one end of the brake band. The brake band is flexible, and the other end abuts against a fixed anchorage. Moreover, the angle at which the magnet lug pushes on the band end is such as to give a decided outward component to the thrust. Hence the band is forced outward against the drum, braking the vehicle. Although the magnet only rotates a short distance with the armature, the force between them still exists, so that the braking force continues to be applied until the vehicle comes to a stop or until the current is shut off. The lining is applied to the band in short sections, and is quite thick. A strong spring returns the magnet to position and releases the brake when the current is cut off. The regulating mechanism consists of a series of metal strips with which contact is made by an arm that

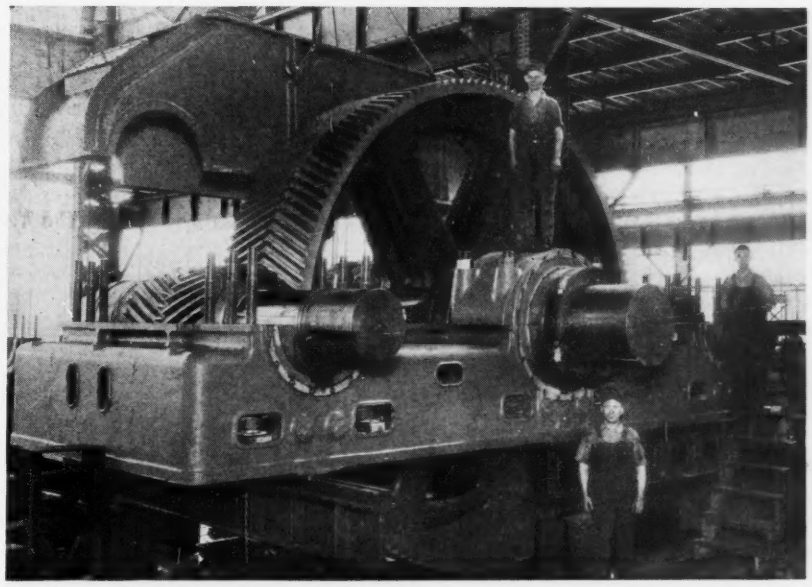
is moved as the brake pedal is pushed in. As the arm touches each strip, a new resistance is thrown in parallel with those already connected, thus increasing the current. The last one connects directly to the brakes, thus insuring against failure in case a resistance should burn out. In case one of a pair (front or rear) fails because of short circuit, broken connection, etc., the other is also cut out of operation, but the other pair still operate.

The advantages of this type of brake are many. The system is very simple, consisting only of the brakes, the control blocks, and the electric cable; the brakes themselves are simply constructed. The driver furnishes none of the power, the pedal acts merely as a switch, with the pressure resisting the foot supplied by a spring whose tension can be varied to suit the individual. The amount of braking power available can be regulated according to road conditions if desired, by a dash control. The brakes need no adjusting and very infrequent relining, as the magnet will rotate until the brake grips, and the flexible band will conform to the drum, taking up any wear. The magnets can be designed to give any desired power.

An Exceptionally Large single-reducer gear was recently completed for the use of a Tennessee manufacturer. The gear was made in one piece, weighing eighty-one tons, and is of the herringbone type. It has one hundred thirty-nine teeth and is meshed with a twenty-seven tooth pinion forty-eight inches wide.

The single-reducer unit, which is entirely enclosed, will be used with two 3,000 H. P. motors, reducing their speed from 90-180 r. p. m. to 17.5-35 r. p. m.

The size of the gear is strikingly shown in the accompanying illustration of the unit, with the men as a comparative standard of measurement.



Courtesy American Machinist

This large reducer gear weighs eighty-one tons and reduces the speeds of two 3,000 H. P. motors.

Several Locomotives of unusually high pressure have been built in this country and abroad in an effort to reduce fuel consumption. Among the most interesting of these is the fourth constructed in Germany.

The firebox consists of a series of small tubes, through which steam from a high-pressure evaporator is pumped. It is superheated to about 843 degrees Fahrenheit. The pressure is 1,700 pounds per square inch. Three-fourths of this steam passes to the high-pressure evaporator, which is a vessel containing water. The steam enters under the water-level, and gives up its super-heat in evaporating the water. The saturated steam thus produced is pumped to the firebox superheater to continue the cycle. It has been found in practice that this indirect heating system does not allow the deposition of scale.

One-fourth of the steam, on emerging from the superheater, passes to the high-pressure cylinders. Because of the high pressure, these cylinders are only 8.66 inches in diameter. There are two, one on each side. They exhaust at about 256 pounds pressure, and this steam passes through an oil separator to a heat exchanger. This is a boiler, through the tubes of which the exhaust flows and condenses. The water is pumped into the high-pressure evaporator.

The saturated steam generated is superheated before entering the single low-pressure cylinder between the frames.

The running gear, weight, and clearances are similar to those of the standard German Pacific (4-6-2). The power requirements are the same, and the new machine is being tested in road service.

Theoretical considerations indicate a fuel economy of 47 per cent. An economy of 40-45 per cent is actually expected. Of course, the added complication of the boiler will increase maintenance, but it is believed that this will not be excessive. The designers believe that the heat-exchanger can be omitted from future designs, the high-pressure cylinders exhausting directly into the low-pressure.

A Mixed-Pressure Turbine was adopted as the solution of some peculiar problems confronting a copper company. There was a waste-heat set of boilers operating at 150 pounds, which supplied two old turbines and a number of other engines. Several 200-lb. hand-fired boilers were available for stand-by.

An increase in demand for power could not be met by the existing waste-heat plant, and it was decided to install a 400-lb. boiler, burning pulverized fuel. The 200-lb. boilers are not used ordinarily, but are retained for emergency. Under the new system, the waste-heat boilers are used to the limit of their capacity, to supply steam to two of the turbine nozzles. An automatic valve closes the supply if the pressure falls below 150 pounds, so as not to reduce the power of the units which depend on these boilers exclusively. When this power is insufficient, an automatic valve admits steam from the 400-lb. boiler to the other two nozzles.

In designing the turbine, the primary consideration was the performance at a power requirement of 4,200 kw., but provision was made to increase the load to 6,000 kw. when it becomes necessary. Because the turbine will not carry full load, using steam from one of these two supplies exclusively, provision is made to use steam from the 200-lb. boilers in either set of nozzles.

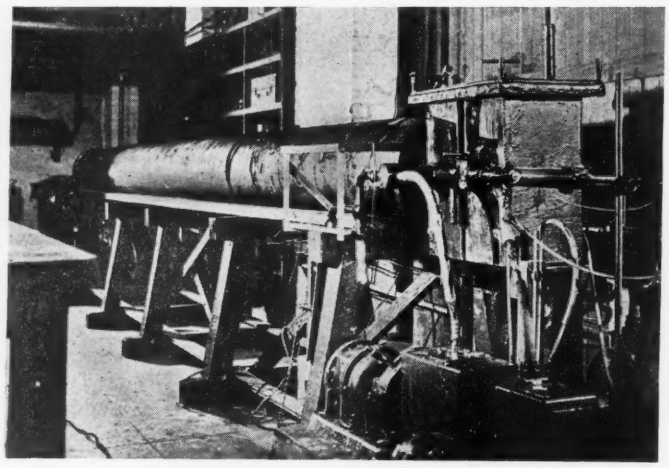
The great flexibility of this turbine is further illustrated by the fact that it can be converted into a normal turbine working at from 150 to 400 pounds, with no radical changes except in the valves.

Departmental Notes

DEPARTMENT OF PHYSICS

The New Building

Plans are practically completed for the new research building for physics and chemistry. This will be Building 6, to join Buildings 2 and 8, and will face toward Walker and the dormitory group. Chemistry will occupy the end near the river, physics the other end, and in the middle there will be shops in the basement, lecture rooms on the first floor, class rooms on the second floor, and library and seminary room on the third floor, for the use of both departments. The building will be entirely for research and advanced teaching, and will greatly relieve the present congestion in the physics department, where no provision for research was made in the original plans of the building. As part of the new building project, there will be a spectroscopic laboratory, situated in the court to be formed by Buildings 6, 8, 4, and 2, and connecting with the new building. This will be a low windowless structure, containing rooms for mounting the various large diffraction gratings, as well as smaller rooms for smaller instruments. With a large grating, like the 35-foot one which will be used, the whole room, 40 feet square, with its contents of gratings, photographic plates, and other accessories, forms the optical instrument and must be kept extraordinarily steady and constant in temperature.



The source of light in the 21-foot vacuum spectrograph is at the near end. After passing through a slit, the light traverses the evacuated tube, is defracted by the grating at the far end and returns to the camera box at the near end, where it strikes the photographic plate.

Professor Scherrer's Lectures

The whole institute has been showing remarkable interest in Professor Scherrer's lectures in atomic theory with demonstration experiments, to judge from the difficulty of obtaining seats in the lecture room. The department hopes in the future to make a good deal of use of demonstration lectures in the elementary teaching, and Professor Scherrer's beautiful technique will not be entirely lost when he leaves. The apparatus which he uses is entirely the property of the Institute, most of it having been already here, the rest purchased for the occasion. Professor Hans Muller, who has been assisting Professor Scherrer in setting up the experiments, has had a great deal of practice in such things, having been assistant in Zurich at the time when Professor Scherrer was devising many of these experiments there.

Spectroscopic Research

Professor Harrison, who has just joined the department, coming from Stanford University, has brought with him a very active research program in spectroscopy, particularly in the intensity of spectral lines. Most of the apparatus which he has brought will not be set up until the new spectroscopic laboratory is completed, but he is working, in the basement of Building 2, with his 21-foot vacuum spectrograph, the largest one which has ever been built. This is shown in the accompanying illustration. This instrument makes it possible to photograph the spectrum in the far ultraviolet region, where the air is opaque and must be removed, with the resolution which has previously been obtained only in the visible and near ultraviolet region. The difficulty of the experiment is obvious when one realizes that the whole apparatus, almost 25 feet long, must be exhausted to the highest attainable vacuum. Professor Harrison has a considerable number of seniors, graduate students, and assistants working with him.

Colloquium and Seminary

The arrangement of seminaries has been somewhat changed this year. On Thursday afternoons are held colloquiums of general interest, both for experimental and theoretical physics and for allied fields. These are intended not merely for the staff, but also for graduate students and any undergraduates who might be interested. Then on alternate Tuesdays there is a more advanced seminary, operated jointly by Harvard and Technology, and meeting first at one place and then at the other. This year, problems of rates of reaction, kinetic equilibrium, and such things are being considered, and the seminary is being attended not only by physicists, but by chemists and astronomers as well. In addition to these, there is a small seminary for seniors and graduate students, conducted by Professor Harrison, and intended as practice in looking up topics and reporting on them.

Prospects for new Research

With the opening of the new laboratory, which it is hoped will be next year, a number of new additions will be made to the staff, and new types of research will be started, in addition to an amplification of present work. One field will be that of discharges and arcs, a field where Professor Knobel and Dr. Killian are already working, but in which there will be a considerable increase. President Compton will bring from Princeton his own work along this line. Also, there will be new men in theoretical physics. This field has been strengthened this year by the return of Professor Frank from Europe, where he worked with Professor Sommerfeld in Munich, and collaborated with him in writing a paper; by the transfer of Professor J. A. Stratton from the Electrical Engineering department; and by the appointment of Professors Slater and Langer. In theoretical physics also there will be a National Research Fellow, Dr. L. A. Young, from the University of Michigan, who will arrive probably in December.

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Recent Books

STRENGTH OF MATERIALS. Parts I and II. By S. Timoshenko. D. Van Nostrand Co., Inc., New York. Part I. 368 + xii pages. Price $3.50. Part II. 334 + xi pages. Price $4.50.

As the size and cost of structures are constantly increasing, a severe demand is made upon the engineer and designer to produce an economical as well as a reliable design. To meet this need Prof. Timoshenko of the University of Michigan has written these two volumes.

Part I, designated as "Elementary Theory and Problems," is written for the undergraduate and deals with the usual theories connected with the subject of strength of materials, with the order of presentation somewhat changed. Thus we find stresses in cords and cables considered in chapter one with tension bars and compression members. Under combined stresses in chapter two, we find the relation of stresses and strains taken up concisely and with very few derivations. In fact, the author has clearly stated in the preface that he has endeavored to simplify all derivations as much as possible. To this end he has made use of Mohr's circle: a graph used in the study of principal stresses in Part I, as well as in many of the advanced problems of Part II.

In the flexure theory, not only has he used the analytical method, but also the area-moment method for the deflection of beams under different types of loadings and different constraints.

The space devoted to the very important subject of continuous beam is altogether too limited and is the only part of the beam theory that has not been very thoroughly developed and illustrated.

Some of the other interesting features of Part I are: bending of beams, the materials of which do not follow Hookes' law; bending beyond the yielding point; combined bending and twist in rectangular and elliptical shafts; twisting of I beams and channels, bending of beams in a principal plane which is not a plane of symmetry, eccentric loading of a long strut in a principal plane, open coiled helical springs. Reinforced concrete beams are touched upon briefly, but unfortunately the standard nomenclature is not used.

The last chapter considers the various kinds of strain energy or resilience due to bending, tension, and twisting, as well as the Theorem of Castigliano, with applications.

Finally, the appendix appropriately gives, with illustrative examples, a brief treatise on moments of inertia, products of inertia, and principal axes of inertia.

Part II, designated as "Advanced Theory and Problems," is written for research engineers and for advanced students interested in structural engineering and in machine design. In all cases the author has succeeded in simplifying his derivations and keeping them inside the usual limits of engineering mathematics.

In this volume we find: theoretical discussions and solutions for such problems as bending of long struts and tie-rods when subjected to lateral loads; a long chapter devoted to curved bars, in which stresses in hooks, in the rim of a flywheel, in a plate with a circular hole, as well as the deflection curve for a bar with a circular center line, are worked out.

Thin plates, thick cylinders, rotating discs, and shrink fits are also carefully analyzed in addition to the buckling of bars, plates, and shells.

All designers realize the great irregularities in stress distribution due to abrupt changes in cross-section. Professor Timoshenko has therefore devoted an entire chapter to a discussion of stress concentration in tension, compression, bending and torsion, followed by a discussion of investigations by means of models and the photo-elastic method.

And finally, no text on strength of materials would be complete without a chapter on the mechanical properties of materials, and the author has chosen to place this at the end of Part II.

The author is to be commended for his very generous use of cuts to illustrate the text and thereby aid the student in his study of the theory; for his great variety of well-chosen problems with solutions; as well as for his numerous references to other texts and original papers.

LAWRENCE S. SMITH.

GENERAL PHYSICS. By W. S. Franklin and G. E. Grantham. Franklin and Charles, Publishers, Lancaster, Penn. 705 + XVI pages. Price $4.00

The latest, and the last, textbook from the pen of Professor Franklin, this time in collaboration with W. E. Grantham, appears as a volume of over 700 pages, subdivided into sections on Mechancis, Heat, Electricity and Magnetism, and Light and Sound. More than any other author, Franklin has unmistakably marked his long series of Physics texts with the imprint of his own personality, and this volume is no exception. The pungent, forceful, and often humorous and homely footnotes and interjections, and the interpolated essays, leave in one's mind as much the impression of a long talk with an earnest and kindly teacher, as does the body of the book that of a clear and precise treatment of physical principles.

The approach to Mechanics is through Statics, followed by a chapter on Work and Energy. It may be mentioned in passing that the word *weight* is given its everyday significance, and is used interchangeably with *mass* throughout the text. The term *earth-pull* is adopted to replace *weight* as usually defined. Kinematics, and Dynamics of Translation and Rotation follow, concluding with a rather thorough discussion of the gyroscope.

The two succeeding chapters are devoted to Hydrostatics and Hydrodynamics, the treatment of the latter being unusually complete for an introductory text. The chapter on the Statics of Elasticity develops the concepts of longitudinal, isotropic, and torsional stress and strain, but devotes rather more space to the theory of the bent beam than seems desirable in a course where this matter is not to be pursued further.

In the section on Thermodynamics and Heat, as well as throughout the book, every opportunity is taken to point out modern contributions to the subject. Examples are the Einstein-Debye theory of specific heats, and Einstein's derivation of Planck's equation. The dynamical theory of gases is carefully developed, and includes the Maxwell distribution law, a discussion of mean free path, coefficient of viscosity, coefficient of thermal conductivity, and the equi-partition theorem.

The chapters on Electricity and Magnetism open with a discussion of the flow of current, Ohm's Law, and the magnetic field. The concept of magnetic field

(Continued on page 286)

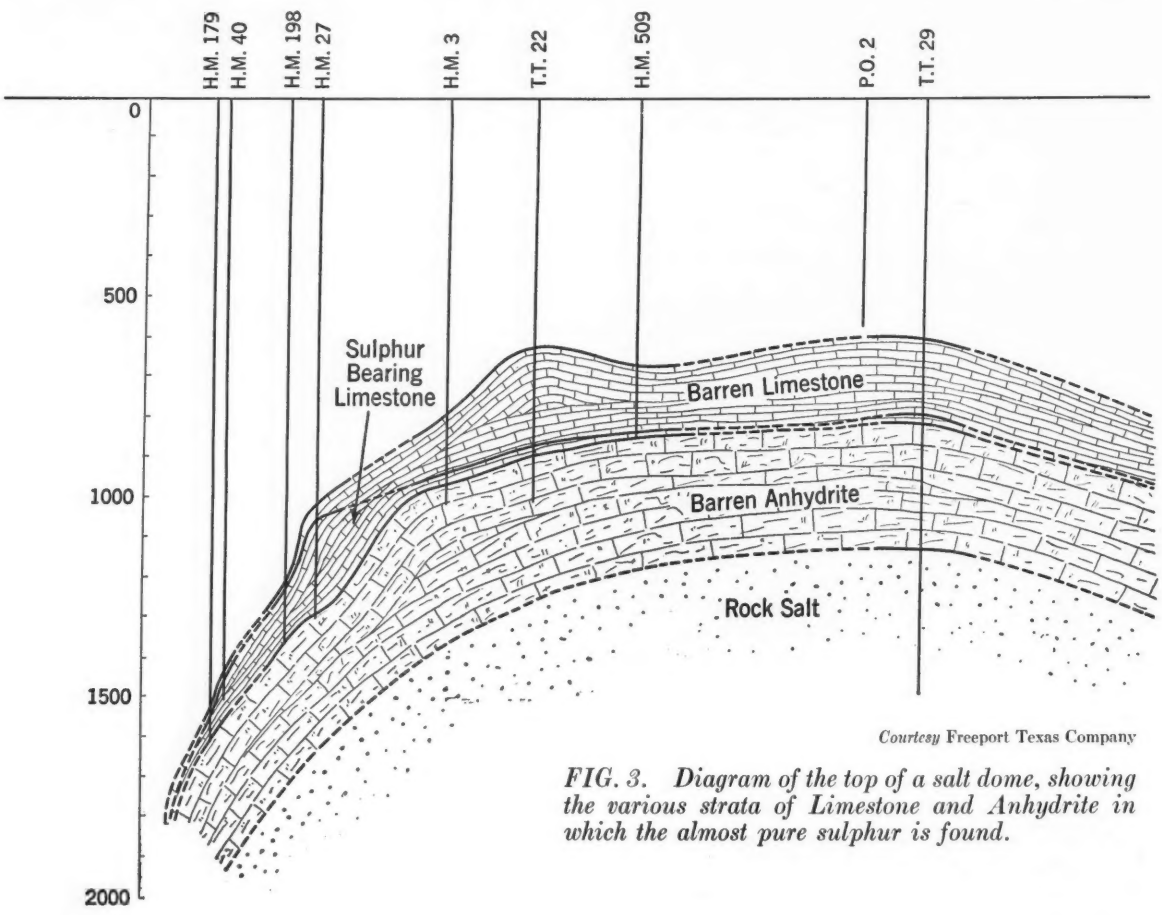
Sulphur

(*Continued from page 259*)

Not only from the records of wells drilled, but by geophysical investigations permitted by the relative density of the salt, cap rock, and surrounidng sediments, by gravity determinations, and by seismograph their positions and shapes have been studied. Today some 200 salt domes are known and a clear idea of the characteristic form and occurrence has been obtained.

The arched cap rocks lie at depths varying from a few hundred feet to several thousand feet below the surface and may even be exposed at ground level in rarer instances. The thickness and composition of the cap rocks also vary. The sulphur dome in Louisiana has a cap 1100 feet thick, strongly arched, with its top only 350 feet from the surface. Other domes have thin caps overlying the typically lesser arched salt surface. Limestone is present in most cap rocks and is usually found nearer the surface than underlying anhydrite. Gypsum also may be present, perhaps as interlayered beds between the limestone and anhydrite. The flanks of the salt mass are steep. Dips of the salt border increase from the flat top to angles near the edge that may reach the vertical. Overhanging projections even have been discovered by the drill. The flanks of salt are in direct contact with the surrounding soft sediments of the Coastal plain to the greatest depths drilled at present, about 8,000 feet. The salt dome is thus a pipe-like mass of salt (Fig. 1) capped by hard porous rock and surrounded by sedimentary formations bent up on its flanks.

The origin of these bodies is believed to be from a thick bed of salt at great depth. Such beds, 1500 feet thick and covered by beds of anhydrite, occur in West Texas near the surface. Folding of the rocks and pressure from the great thickness of overlying sediments are believed to have caused flow, such as occurs in glaciers, in this deep-lying salt bed and to have forced the salt into the soft superincumbent sands and clays. The plug-like mass has probably carried fragments of overlying beds of anhydrite and limestone upward on its top during the slow movement of penetration and these fragments, greatly crushed and distorted, constitute the present cap rocks. Geophysical work indicates that the salt beds (Fig. 1) lie at depths of not less than 15,000 to 20,000 feet.

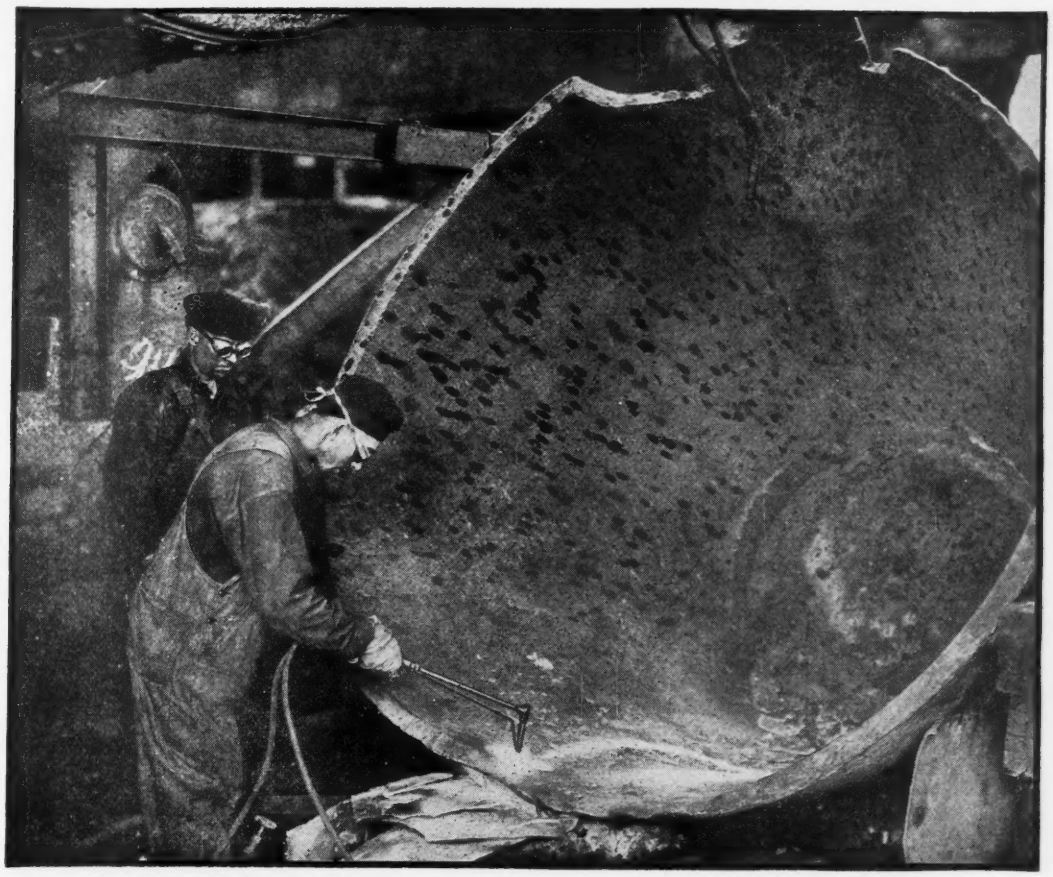


Courtesy Freeport Texas Company

FIG. 3. Diagram of the top of a salt dome, showing the various strata of Limestone and Anhydrite in which the almost pure sulphur is found.

Petroleum occurs related to the salt domes both in the porous cap rocks and in porous bent-up sands near the salt on the flanks. Associated with it are salt waters containing hydrogen sulphide. The sulphur is found only in the porous cap rocks and in relatively few salt domes. It occupies cavities and fractures in contorted beds of limestone or gypsum above solid compact anhydrite (Fig. 3). The greatest thickness of sulphur-bearing rock is usually near the edge of the cap rock, although some good deposits existed on the flat top at Sulphur, Louisiana, and at Bryanmound, Texas.

(*Continued on page 277*)



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Windowless Factories

(*Continued from page 264*)

where noise originates to intercept the wave action. In dampening, the material is restrained from giving out sound after the fashion of a tuning fork.

The roof of the building is of particular interest. Like the walls, it is wholly solid, being of a metal acoustical type of high efficiency. The first layer of the roof's composition is a structurally strong perforated metal roof deck to permit passage of sound. Above this is an inch-and-a-quarter layer of rock fiber bound with asphalt. Over this are two one-half-inch layers of insulating board secured in asphalt. On top of this is a built-up water-proofing. In addition to sound, absorption qualities, the roof has insulating qualities as well, keeping out heat from the sun in summer and retaining heat within the building in winter.

The walls of the building will be acoustical block with a facing of brick for architectural effect. It is expected that the building will absorb at least 60 per cent of the usual sounds. Due to the acoustical arrangements, it will be possible to locate the plant office at one unpartitioned end of the building. Workmen near large machines will be able to converse in ordinary tones.

Color Schemes

The plant also will embody the latest results of psychological research into the effects of color in depressing or energizing human beings. It is well known that certain colors produce certain effects on the mind and certain nervous reactions. Some are stimulating, while others have a sedative effect. Colors for the interior have been selected with a view of attaining the best possible reaction from workmen, tending to keep them in a cheerful and active frame of mind while employed.

The color scheme of the interior is blue, green and white for the walls and ceiling. The blue will reflect certain ultra-violet rays from the lamps. Green is the active or energizing component, while white is for the sensation of light and to reflect cleanliness.

The company will initiate orange as the color for machines. The color was selected because it will lift the visibility of machine parts and aid in accident prevention.

The machinery layout of the plant will provide for straight-line production and it will be planned to reduce industrial fatigue to a minimum. Unnecessary motions will be eliminated from all operations and physical effort of the workmen will be reduced as much as possible.

The building will be of single-story construction with no partitions and only 56 columns in the entire structure. The reduction in the number of columns has saved much space, each column consumes a space of a radius of five feet.

One of the interesting features of the new plant, and one which is in harmony with the advanced ideas prevailing in its design, is the fact that washroom facilities for employes are to be comparable with the best of such facilities in the finest of city skyscrapers. Floors and walls will be of white tile and all fixtures will be of the latest type.

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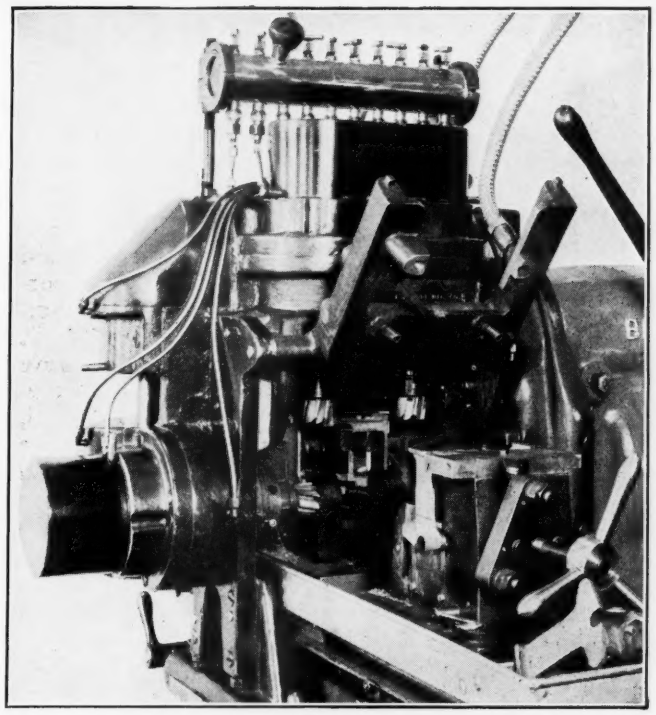

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For such work—the production of duplicate inter-changeable parts—Brown & Sharpe No. 21 Automatic offers unusual production possibilities.

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BROWN & SHARPE

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Sulphur

(*Continued from page 274*)

The origin of the native sulphur has caused much discussion. Recent investigations by Dr. Waldemar Lindgren and the author indicate that considerable quantities of calcium sulphate have been altered in the cap rocks to calcium carbonate, limestone, by the action of sodium bicarbonate waters flowing into the cap rocks from water-bearing zones in the surrounding sands. It is quite probable that the hydrogen sulphide waters of the deeper flanks may rise on the salt contact, meet the carbonate waters and, on mixing with them in the zone of alteration of calcium sulphate, precipitate the sulphur contained in solution as sodium sulphide in the form of native sulphur. Precipitation of sulphur by bacteria has also been suggested.

With the development of geological knowledge of the occurrence of sulphur, new discoveries were made. In 1912 Bryanmound, Texas, was prospected and with its exploitation the American monopoly of the Union Sulphur Company, the owners of the Louisiana dome, ceased to exist. Later the sulphur-bearing salt domes at Hoskins Mound and Gulf, Texas, were opened up and in recent years the smaller developments at Palangana and Long Point and the great deposit at Boling, all in Texas, were put into production.

As a result of early discoveries, sulphur output in the United States rose to 2,036,097 long tons in 1923. After this time considerable reduction in production was caused in 1924 by the exhaustion of the Sulphur, Louisiana, deposit, but increase continued through later years to a maximum in 1929 of 2,362,389 long tons. These figures may be compared with Sicilian sulphur produced in the same year to the extent of about 200,000 tons and Japanese production of somewhat over 65,000 tons.

In 1929 the United States exported 855,500 long tons of sulphur and consumed 1,582,000 tons. Utilization of this quantity was distributed as follows:

Heavy chemicals	560,000 tons
Fertilizers and insecticides	415,000
Pulp and paper	265,000
Explosives	67,000
Dyes and coal tar products	47,000
Rubber	43,000
Electro-chemicals	23,000
Fine chemicals	15,000
Paint and varnish	5,000
Food products	5,000
Miscellaneous	137,000
Total	1,582,000 tons

The use of sulphuric acid is widespread in industry, large quantities being required in petroleum refining, in iron and steel treatment, and in metallurgy. Therefore, although the sulphur mining industry ranks only seventeenth in the United States in the value of its product, it affects a most varied list of manufactures and the consumption of sulphur serves as a first-rate index to business conditions.

The future of this extraordinary mining in the liquid form is of considerable interest. Some apprehension was felt in 1924 with the closing of the Louisiana plants as to possibilities of maintaining large sulphur production on the Gulf Coast, but more recent developments have tended to a more optimistic outlook. Although but seven commercial sulphur domes have so far been found in about 200 known salt domes, many domes have been inadequately explored and future discoveries are probable.

Anti-Freeze Solutions

(*Continued from page 265*)

lower percentage of alcohol did crack. The mass, extruded from the flask, resembled mushy snow or sherbet in consistency.

While this strength of solution will protect the motor from injury by freezing, it must be remembered that masses of mushy ice seriously interfere with the circulation of the coolant; to prevent this trouble the mixture should be made richer in alcohol.

Ethylene glycol $C_2H_4(OH)_2$ is made, as might be expected, from ethylene, a gas produced in vast quantities in cracking oil to make gasoline. The gas is treated with hypochlorous acid, with which it forms a liquid, which is further treated with soda solution, concentrated and distilled like glycerine. Glycol is stated to lower the freezing point of water more than either alcohol or glycerine, to have little or no corrosive action upon metals and no deteriorating effect upon rubber. Like glycerine and alcohol, if mixed with water in all proportions, an aqueous solution of the substance freezes to mushy snow, and it is non-volatile. Its boiling point is 387° F. (197° C.).

It is reported that a well-known car is to use the pure substance as a coolant in a sealed system; greater fuel efficiency is attained at the temperatures of about 300° F., as compared with aqueous solutions at 180° F. For aeroplanes, additional advantages are found in diminishing the cooling surface and volume of cooling liquid, thereby cutting down the air resistance and weight.

As both glycol and glycerine are somewhat expensive, all joints and connections must be tightened, particularly pump packing, cylinder head and hose connections. Hose in the course of time becomes water-logged, and when either of these alcohols is used the solution absorbs water from the hose, causing it to shrink and leak. Hence, after filling with either of these solutions, the cooling system should be watched for leaks.

Glycerine or Glycerol $C_3H_5(OH)_3$ is prepared by the saponification of fats and oils, the purification and concentration of the soap lyes and subsequent distillation of the glycerine. It is miscible with water in all proportions, has a boiling point of 556° F. (291° C.) and is non-volatile. The radiator mixture boils at 220°-225° F. It does not carbonize in the motor. Glycerine solutions are stated to be without action on the metals, and not to freeze solidly on freezing, since they are, when chilled, usually in the condition of mushy snow. They have the fault, if it may be called such, of being unusually good solvents or looseners of chalky deposits and iron rusts in cylinder blocks and in radiators, uncovering pinholes which have been stopped by such sediments. This is the cause doubtless of the complaints that they are really corrosive: they act to disintegrate old rubber connections. If the radiator, cylinder block and connections are thoroughly washed out and new rubber hose installed, it is stated that aqueous solutions of glycerine give eminent satisfaction and immunity from breakage by freezing. Neither they nor glycol solutions affect the finish of the car as does alcohol.

Having stated the merits and demerits of each coolant, the question naturally arises — which to use? The mixture proposed twenty years ago, for the old 2-cylinder Ford, of 3 gallons of water, half a gallon each of glycerine (about 5 pounds) and of denatured alcohol, appeals strongly to the writer. It will always protect, even if the alcohol boils completely off. It may, in the latter instance, in case of extreme cold, freeze to impair circulation, but this can be remedied by careful thawing and then adding alcohol. It has the advantage of cheapness, the glycerine costing about a dollar. It has the additional advantage of helping the markets both for alcohol, of which there is a scarcity (40 million gallons being used as an antifreeze medium), and of glycerine, of which there is an abundance.

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THE SIXTH SENSE OF INDUSTRY
The use of Tycos Temperature Instruments, indicating, recording and controlling, in industry minimizes the possibility of error and eliminates the waste of spoilage.
They indicate, record and control temperature with scientific accuracy and precision that means thousands of dollars saved to the industry every year. Write for catalog, mentioning the particular industry in which you are interested.
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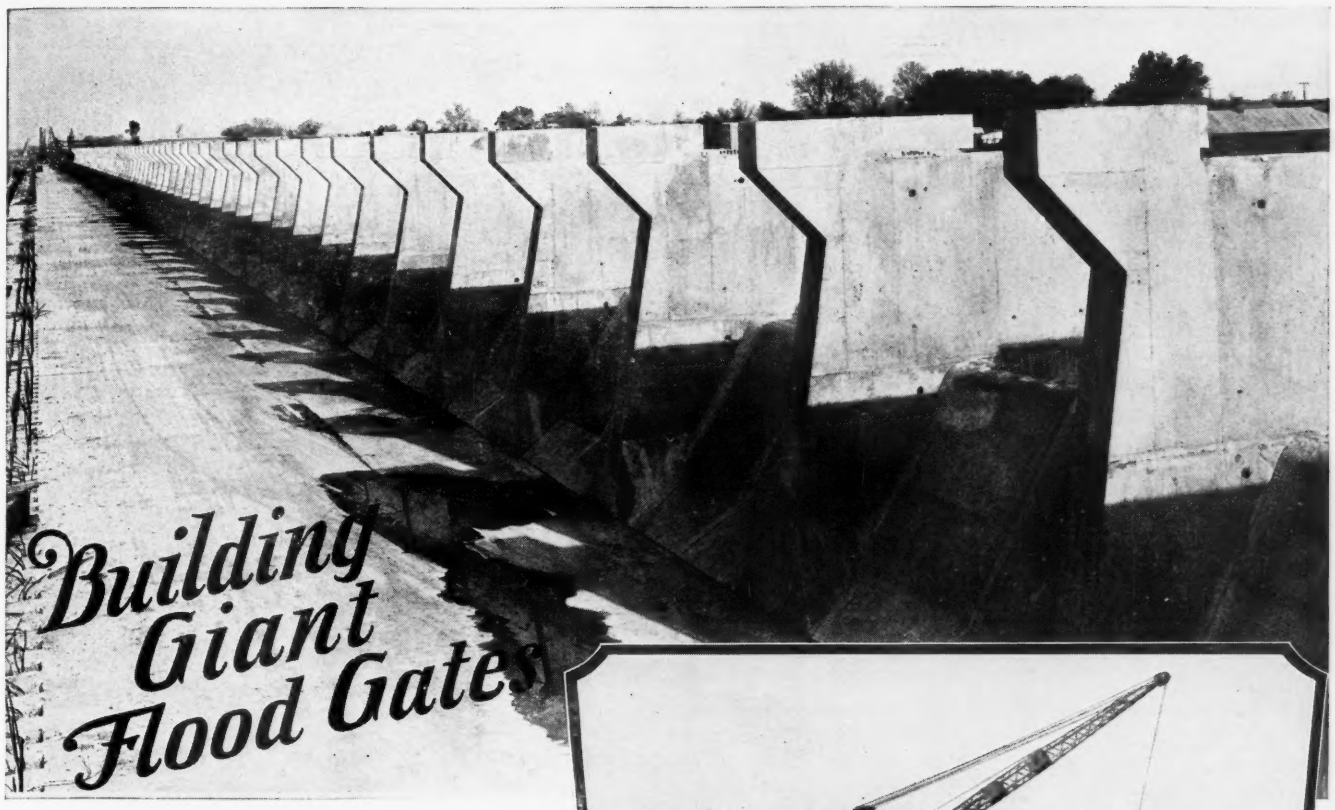
INDICATING RECORDING CONTROLLING
TEMPERATURE INSTRUMENTS

Sunlamps for Health Building

(*Continued from page 263*)

(7) increase in the percentage hatchability of eggs;
(8) elimination of necessity of feeding relatively expensive anti rachitic foods.

Perhaps a little more is known of the benefits of ultraviolet to chickens than to human beings for the chickens can be made sick, irradiated, killed, and the effect of the irradiation measured by burning the bones and measuring the calcium content. Such a procedure is, however, hardly practical with humans. There is ample evidence that the two respond similarly. Though it may take a little longer to measure definitely exact benefits to humans, we are sure they will be large. The introduction of the new Sunlamps, making it possible for the general public to take advantage of these benefits, will undoubtedly prove a big step in advance in the progress of maintenance of general health.



Building Giant Flood Gates

TWENTY-EIGHT miles upstream from New Orleans a great flood gate known as the Bonnet Carre spillway is being completed. In times of high water this concrete dam on the east bank of the Mississippi will tap the flood before it reaches the city, diverting the dangerous excess into Lake Pontchartrain.

The Bonnet Carre spillway consists of a concrete dam and a pier-and-weir section about 7700 feet long. The weir sections, which are twenty feet wide between the piers, have timber needles on the crests at two levels — elevations 16 and 18 A traveling crane, on a bridge spanning the piers, removes the timber needles for discharge.

N. E. C. equipment played an important part in the construction set-up. Two Koehring Cranes handled aggregate at the material bins and a third Koehring placed the concrete with an Insley bucket. Two large Smith mixers mixed the 127,000 cu. yds. of concrete used on the project.

Wherever you find construction work in progress, you find N. E. C. equipment!

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KWIK-MIX
Mixers — Concrete, Plaster and Mortar.

National Equipment Corporation

30th St. & Concordia Ave.
Milwaukee, Wisconsin

The Engineer Guards the Health of the City

(*Continued from page 257*)

Poisoning by carbon monoxide, unfortunately, does not yield to preventive measures so easily. In spite of unceasing efforts, the number of deaths from this cause remains high. Perhaps this high rate may be partially explained by the fact that it is an easy death for those who lack the courage to face life's battles, and it is not always possible to determine whether a death is suicidal or accidental when it occurs from this cause. Of perhaps greater significance is the chronic non-fatal poisoning by carbon monoxide suffered by workers in poorly ventilated garages, foundries and similar places where incomplete combustion of fuels and other organic substances takes place. The supervision over ventilation is one of the duties of the city sanitary engineer, to avoid such conditions.

Ventilation control has two equally important aspects. One has been touched upon already, namely, the removal of dangerous substances such as carbon monoxide. Other materials are dust, especially lead and silica dust, volatile chemicals used in industrial processes, such as benzol, various solvents used in spray-painting, and liquids which are thrown into the air in tiny droplets, such as chromic acid used in chromium plating processes. These various substances have different physiological effects upon the worker, but can all be prevented from exerting these effects by efficient collecting systems installed at the point of their origin, thus preventing them from becoming diffused throughout the atmosphere. One difficulty to be constantly encountered by the city sanitary engineer in his efforts to protect the health of the workers is the lack of definite information about some of these matters on the part of the plant executives. In their haste to seize upon new processes, they frequently fail to inquire sufficiently into the question of the existence of a health hazard to the employees. Therefore one of the principal tasks in this field is the education of industry to a proper appreciation of the dangers involved and to prevent harm before it occurs. The broad contacts of the city sanitary engineers place them in a favorable position to make helpful suggestions to plant executives, basing them upon practices which have been found to be successful in other plants. One of the ways of forestalling danger to workmen is to secure competent plant physicians in each factory who will examine all new employees before assigning them to work and also make periodic physical examinations of all workers, old or new, for the purpose of detecting occupational diseases in the incipient stages. By encouraging such examinations, the city sanitary engineer can aid industry in its problem of fitting the man to the job and the job to the man.

The second aspect of ventilation control is the provision of an atmosphere that is not only free from toxic vapors, dusts, fumes and droplets, but is conducive to the most efficient functioning of the human body. This means the supplying of an adequate quantity of air that has the proper amounts of warmth, relative humidity and motion. Good health is difficult to maintain if one is always uncomfortable. It is becoming more and more clearly apparent that comfort has a direct and important bearing upon that state of physical and mental well-being that is called health. The provision of a comfortable atmospheric environment is of utmost importance and the supervision over this phase of public health work comes within the field of the city sanitary engineer. Housing codes usually specify the amount of window space required for different classes of buildings. There are, however, many types of structures, such as theatres, dance halls and other places of public assembly, which require mechanical ventilation in addition to windows. To control such places, supervision must begin before the building is erected, by having the city sanitary engineer examine and approve the plans for the ventilation system before the building permit is issued. Then when the building is ready for occupancy, he should check the system to see that it actually does what it is intended to do, and does it without creating objectionable draughts.

We do not spend all our time in-doors, by any means, and it is important, therefore, to keep the out-door air pure. In cities where coal is the principal fuel, this is no small problem. Dusts arising from the manufacturing processes are usually easily separated in cyclones or electrical precipitators before the air leaves the factory, but the problem is entirely different with flue gases. The true measure of the air pollution from a furnace stack is by no means the blackness of the smoke emanating therefrom. Some processes of firing, such as the use of pulverized coal, which is blown into the furnace, may give complete combustion and therefore no black smoke, yet may load the atmosphere with fine ashes. Smoke control is a function of the city sanitary engineer and the economies that can be effected by securing

(*Continued on page 282*)

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Outstanding in their field by reason of unexcelled accuracy and valuable new features. The illustration shows one notable improvement in Micrometer markings—the Direct Indicating Micrometer

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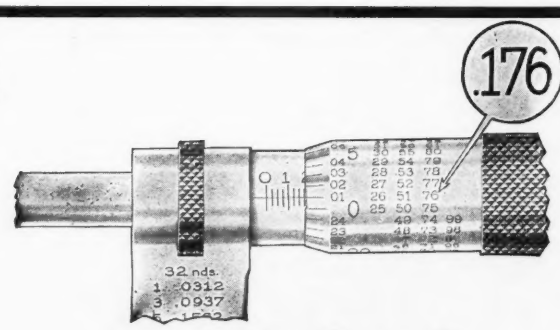

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EXPLOSIVES

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Thus explosives, long used to "bring in" oil wells and to aid in pipe line construction, are finding another important application in the petroleum industry—another indication that explosives are helping us to enjoy a richer, fuller civilization. In these achievements, Hercules explosives are playing an important part.

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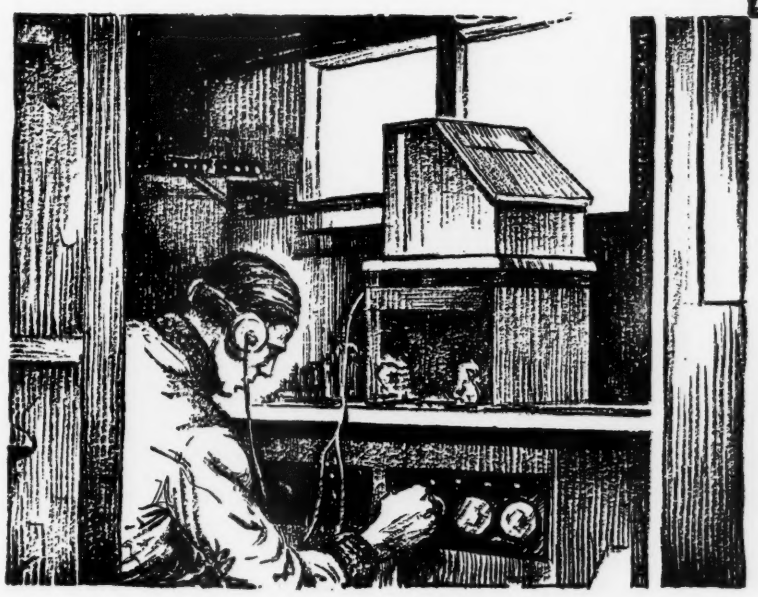


Above: Blasting to determine a possible oil structure by geophysical prospecting (from an actual photograph).

Left: Delicate instruments record the earth vibrations initiated by explosives.

As an engineer, you should know more about explosives. Write for a sample copy of The Explosives Engineer, a monthly magazine which records the growing use of explosives in modern civilization.

H-6

Fig. 651, Flanged, Jenkins Standard Iron Body Gate Valve

Accuracy —

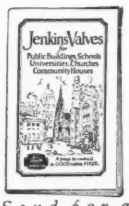
in goal shooting or valve making

Goals in basketball are seldom the result of chance. A high degree of accuracy is called for.

Accuracy counts for as much in manufacturing and the making of Jenkins Valves is a good example. Accuracy enters into every operation from the choice of metals by competent metallurgists to the rigid testing of the finished valves.

Castings for Jenkins Valves are sound and flawless, inspection systematic and constant. Machining is precise, assembly painstaking.

There are Jenkins Valves of bronze and iron for practically every power plant, plumbing, heating and fire protection equipment.



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Jenkins
VALVES
Since 1864

Health of the City

(*Continued from page 280*)

complete combustion through the use of mechanical stokers and other special devices will soon pay for them. Closely allied to the problem of smoke control is the prevention of the pollution of out-door air by dust, powdered building materials and odors. These substances cause neighborhood nuisances near coal and building material yards, cement mills, blast furnaces, asphalt plants, varnish factories, stock yards, rendering plants and many other places. The city sanitary engineer is called upon to give the populace residing nearby relief for which it clamors. Providing storage bins, wetting, while handling, of dusty materials, such as coal, using substances, such as calcium chloride, which absorb moisture from the air to keep down dust, and covering vehicles will do much to abate the dust nuisance. Precipitators have been successfully used in many instances, and the value of the recovered dust has soon paid for the equipment. Odors may often be eliminated by passing the air through scrubbers or furnaces or by chlorinating the air. Better still is to prevent the formation of the odors by improving the manufacturing processes. For example, a certain neighborhood had long complained of odors of ethyl sulphuric acid and amyl acetate coming from a chemical factory. By more efficient washing of the gypsum, which was a by-product, the nuisance was largely abated and at a clear saving to the company.

A study of the monthly distribution of deaths from respiratory diseases, and the number of days per month when the ultra-violet rays in the sunlight are strong enough to produce a tanning effect upon an untanned human skin, shows a distinct and rather surprising correlation. Shortly after the ultra-violet light reaches its minimum in the winter, the deaths from influenza, pneumonia and other respiratory diseases reach their maximum. It is hard to believe that the parallelism of the curves showing these two conditions, plotted inversely to each other, can be wholly accidental. Sometime we shall perhaps discover that ultra-violet light is more important in the actual prevention of disease than has been realized heretofore. Then the public health significance of removing smoke, dust and ashes from city air and letting the ultra-violet light penetrate to the ground level will also be recognized more fully than now.

Many growing children have no chance to go to the country to get their share of ultra-violet light. In recent years the social agencies have given some of those children a taste of camp life during the summer, removing the under-privileged boys and girls from the slums to a healthier and happier environment for a short time. These children, and the wealthier ones as well, go to camp knowing little or nothing about the protection of water, milk and other foods, the safe disposal of wastes such as garbage, sewage and empty cans, and the control of fly and mosquito breeding. As far as possible the city sanitary engineer should inspect camps of this nature and assist in keeping them sanitary.

Supervision over the production, pasteurization, bottling and distribution of milk is another duty of the city sanitary engineer. So much, however, has been written elsewhere upon the control of milk and water supplies that it suffices merely to mention this as a duty.

Housing probably has as large a bearing upon health as any other factor of environment. The city sanitary engineer should examine and approve the

(*Continued on page 284*)

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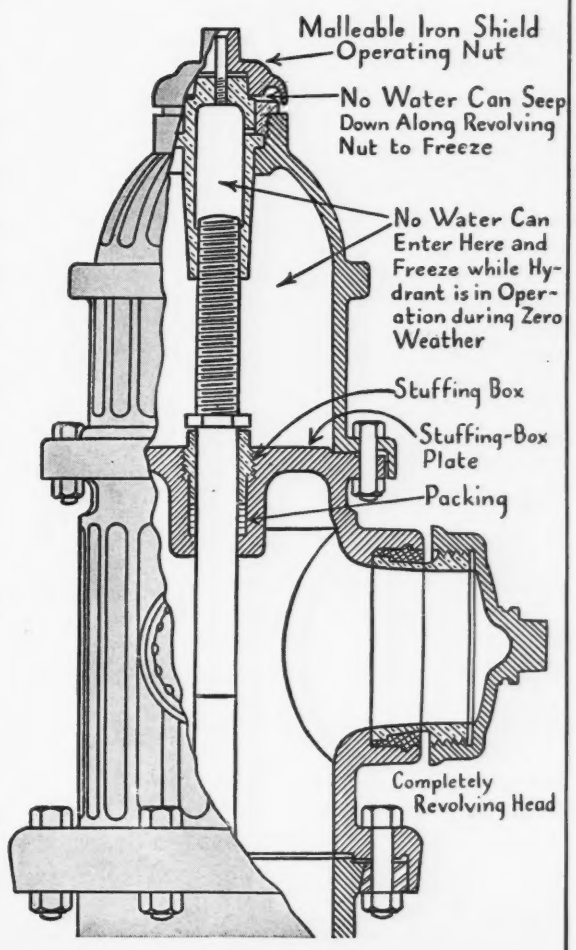
The malleable iron shield nut protects the revolving nut against rain, snow, sleet, stream spray, sand and dirt. This protection is equally important in cold or warm climates because it ensures easy opening and closing without delays for thawing or cleaning. It also provides a tough, long wearing nut for wrench use—a nut not easily scarred or worn.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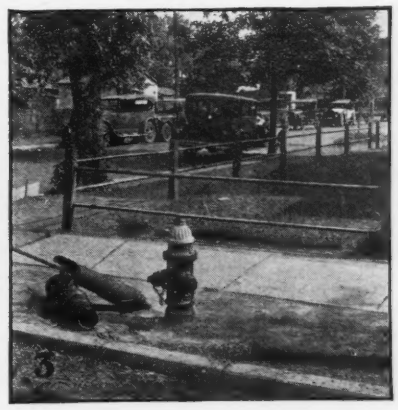
THESE low cost maintenance features—the completely revolving head which permits nozzles to be faced in any direction—the automatic draining feature—the heavy tapered leather main valve—and the protected stem—all mean a greater degree of service and maintenance efficiency with a higher factor of fire protection for the municipalities which have Mathews Fire Hydrants—a leader for more than half a century—more than 350,000 in use throughout the world.

Send for interesting descriptive booklet.

A broken MATHEWS HYDRANT is easily replaced without digging or breaking the pavement



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SAND SPUN
(centrifugally cast)
and PIT CAST
Reg. U. S. Pat. Off.

Health of the City

(*Continued from page 282*)

plans of every place of human habitation before it is built, and furthermore he should see that it is built according to the approved plans. Recent studies have demonstrated clearly that plumbing and public health are closely related, due to the ever-present possibility of polluting the drinking water. Therefore, the city sanitary engineer must be careful not to overlook the plumbing inspection.

Many other fields claim the attention of the city sanitary engineer, varying in importance with the location of his city. In seaports, rat-proofing and plague prevention activities, and perhaps control of shell fish, are important. In the South, malaria fever control and sewage disposal from the standpoint of hook worm infestation are likewise important. The supervision over the purity of the public and private water supplies, over the water in swimming pools and at bathing beaches, and over bottled water and other drinks and over ice is always of great significance. From a nuisance standpoint, garbage collection and disposal, sanitation of comfort stations and stables and the prevention of fly breeding demand a certain amount of time and attention. And lastly, not because there are no others, but because of lack of space to tell of them, there is the duty of educating the public as to the value of having a healthy and sanitary city and of filling every one with the desire to do his part in making it so.

The city sanitary engineer has one of the noblest tasks on earth. Thousands and even millions of citizens trust him to protect their health and lives by his vigilance and foresight. To be worthy of that trust is his aim.

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1855 • SEVENTY-FIFTH ANNIVERSARY • 1930

Steel under the microscope

Burnished mirror-bright, etched in an acid-bath, a shiny square of steel is placed in the projector microscope in the metallography room at Crane laboratories.

To the layman, the texture disclosed is surprising as the filigree design of magnified snowflakes. Sometimes it is like a relief map of mountain ranges, sometimes like finely veined marble, sometimes like cumulous clouds.

But to the scientist in metals who judges it with a connoisseur's eye, the surface tells a far wider story. It discloses coarse, uneven or beautiful fine grains, tells of disproportions and proportions of constituents in the alloy, speaks volumes concerning malleability, ductility, hardness . . . gives a key to action of the metal in service, all based upon knowledge of the product.

Careful metallographic records of all metals used in Crane valves and fittings, painstaking microscopic examination of all new metals offered for possible use, are a part of the check and double check and triple check which is routine in Crane research and manufacturing.

The full story of Crane application of chemistry and science to metals is told in a fascinating book, "Pioneering in Science." It is a valuable reference book for engineering students. On request, we will gladly send you one.

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GETTING THE JUMP

The referee's whistle blows. Up goes the ball. The opposing centers leap into the air and one, a little more alert, a little better endowed by Nature than his adversary, tips it into the hands of a waiting team-mate. So it is in basketball — and so it is in the vastly more important game of life which starts in earnest after text-books and examination papers are finally laid aside.

In the sales departments of Westinghouse, as with other great national organizations, are many younger college men — graduated within the past five or ten years — whose alertness and ability are winning them no small measure of reward. Not only in the sale of electrical goods to dealers, jobbers, and power company stores, but in important negotiations for equipment with central stations, railroads, shipping lines, governments, industrial concerns and building contractors, success depends on the extending of contacts and the ability to "get the jump" on competition. And because of their exceptional engineering training and background, Westinghouse representatives are regarded less as salesmen than as expert consultants in electrification.

The men whose photographs appear on this page are but a few of many who, with college memories still fresh in their minds, are helping Westinghouse to maintain the contacts which keep it busy doing so generous a portion of the world's electrical work.

• • •

The following are but a few of the more outstanding examples of recent Westinghouse jobs, in the negotiation of which younger college men have played a part:

Turbine-Electric Drive, New Dollar Line Passenger Ship ⁄ *Electrification, New York, New Haven and Hartford R. R.* ⁄ *Steam Turbine-Generators, Duke Power Company.*

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R. D. LAWLOR
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J. C. FRINK
Syracuse '27
Marine Salesman
New York

M. S. ANGIER
Univ. of Ill. '24
Sales Manager
Johnstown, Pa.

Westinghouse

Recent Books

(*Continued from page 273*)

strength is developed in terms of the side push on a current-carrying conductor, rather than the force on a unit pole. A chapter on Oscillatory circuits follows those on Inductance and Capacitance.

In the following chapter, devoted to Electron Theory, the measurements of e/m by deflection methods are well described, but oddly enough Millikan's measurements of e are summarily dismissed in only a few lines. One finds no mention of J. J. Thomson in connection with the determination of e/m, nor of Aston in the description of the mass-spectrograph.

Emphasis is laid on Physical rather than Geometrical Optics, with however a very complete treatment of optical instruments. A section on the Rutherford-Bohr atom-model follows the description of the Spectrograph, and the work of De Broglie, Schrödinger, and Davisson and Germer is briefly mentioned. The chapter on Interference and Diffraction is very complete, and includes a discussion of the crystal lattice as a grating for X-rays.

The volume concludes with a section on Acoustics, including vibrations in strings and plates, and a chapter on Architectural Acoustics.

Especial mention should be made of the numerous excellent diagrams, particularly in the section on Optics, which accompany the text. A copious supply of Questions and Problems (most of which include the answers), is provided. Free use of Calculus is made wherever necessary, but in such a way as to be reasily understood by a student who is familiar with simple differentiation and integration. Many references to texts on Modern Physics, and to original articles, are included, an unusual feature in a college text.

The attitude of the book as a whole may perhaps be best brought out by a quotation from its closing page:

" . . . The most distressing idolatry the world has ever known is the modern, popular science—worship which pays no tithes and takes no pains. It is our Great Religion. Its catechism is science teaching which abhors exactions, its litany is the semi-serious wail of regret of the easy college graduate that a silver-spoon smartness was not transmuted by a pleasant college course into what he conceives the talent of its priesthood to be, and its creed is the belief of every spineless parasite who thinks exaltingly that science is the building of steamships to carry him where he has no need to go, of railways to bring him things he could better do without, and airplanes to carry quickly his letters which would not lose in meaning if their time of transit were to take a thousand years. . . .

. . . No. Science is Finding Out and Learning How, its greatest gift to those of us who live inside its frontiers is an understanding of the things that surround us and of the things we have to do, and its price is pains."

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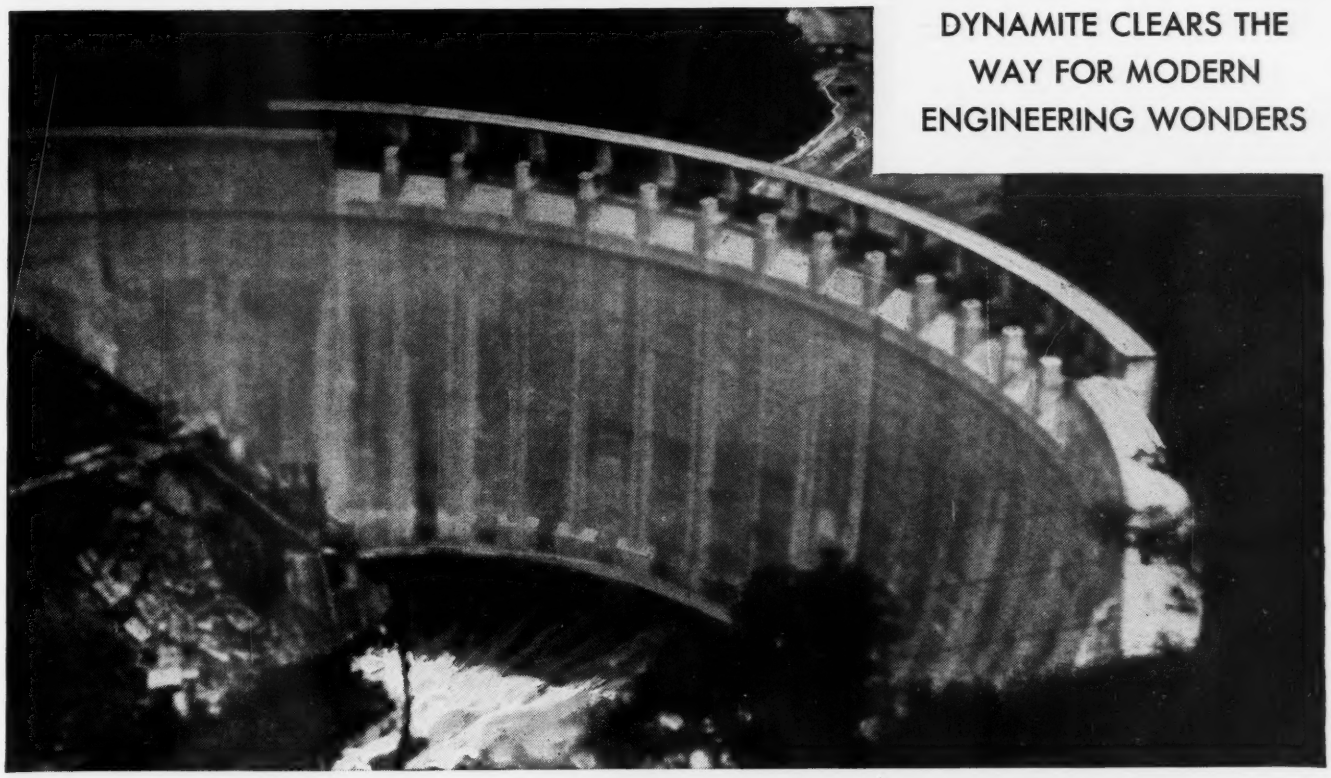

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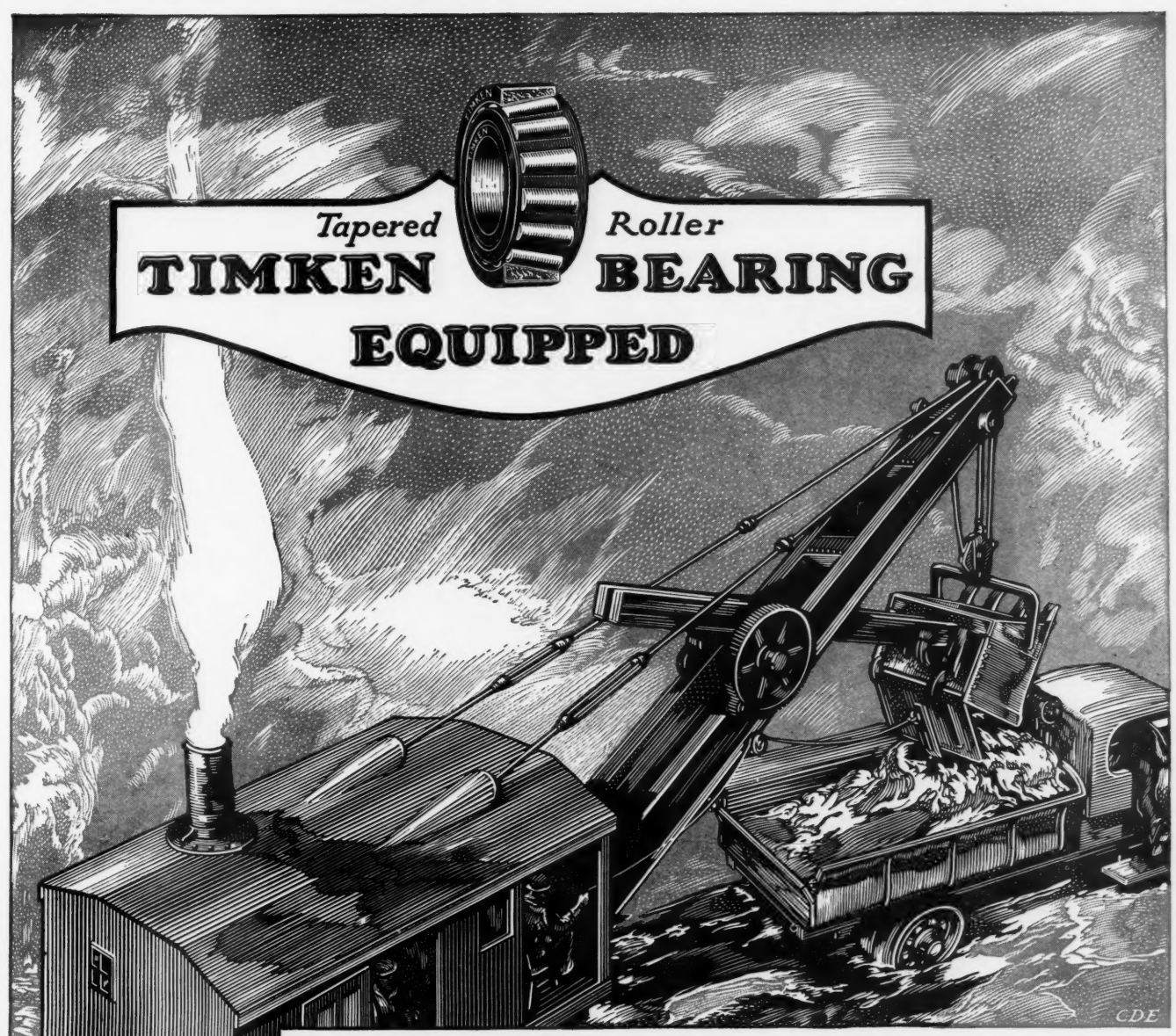

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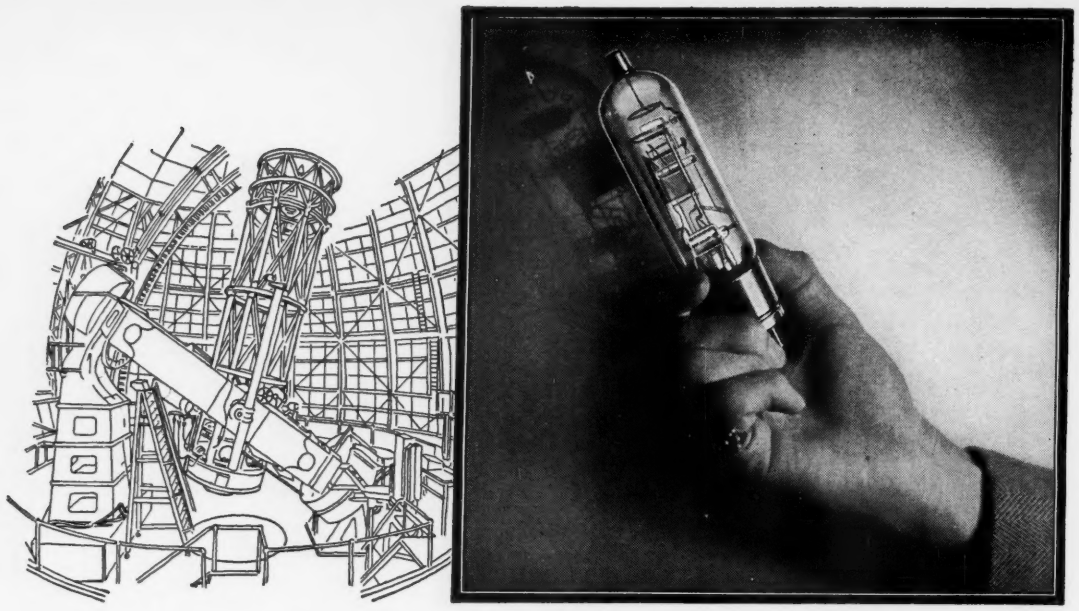

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